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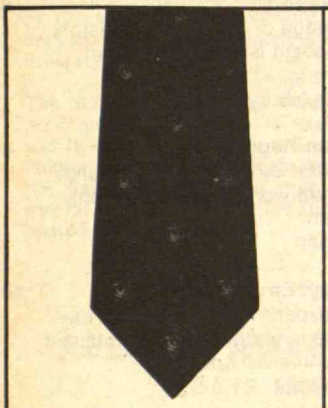

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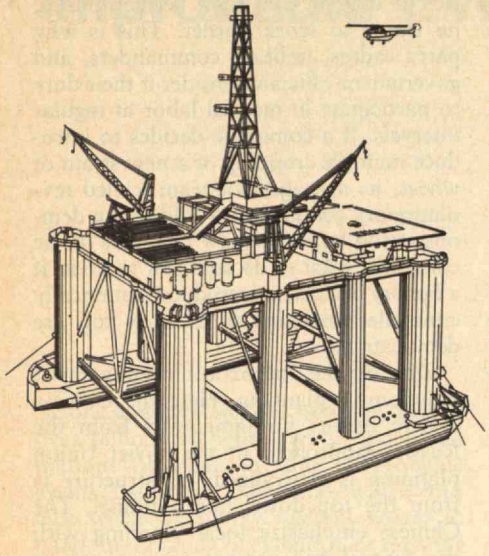


Offshore Oil

This special issue on the problems and promise of offshore oil is due in no small part to the role of M.I.T.'s Sea Grant Program in fostering research on the subject.

Even during 1971, when the federal government announced its tentative schedule of mineral leasing for Georges Bank on the continental shelf off New England, the Sea Grant Program was helping M.I.T. students study the oxidation by marine bacteria of aromatic compounds found in oil. The program was also funding the development of a course on marine mineral resources and exploration methods, and supporting research on the environmental vulnerability of Machias Bay, Maine, to supertankers and on transportation and production strategies for the Prudhoe Bay petroleum fields.

The federal plans for Georges Bank stimulated funding from the New England Regional Commission, the New England River Basins Commission, and the National Oceanic and Atmospheric Administration's Office of Sea Grant for a study of "Offshore Petroleum and New England" through the M.I.T. Sea Grant Program. The result was a series of calculations of economic benefits and ecological hazards for various hypothesized oil and gas discoveries on Georges Bank (*see "Key Issues in Offshore Oil," by John W. Devanney III*, Technology Review, *January, 1974, pp. 20-25*). Both the President's Council on Environmental Quality and the National Science Foundation used the data and analytical models and in 1973-74 commissioned two new M.I.T. studies based on these techniques.

In one of these, information on oil spill likelihood and movement was used to predict the ecological risk from oil spills in the various proposed Atlantic and Alaskan drilling sites. The results are summarized by Professor Stephen Moore in this issue ("*Offshore Oil and the Marine Environment,*" *pp. 60-67*). A second study led to a computer model for the likelihood, movement, and effects of oil spills, explained by Robert J. Stewart in "Oil Spills and Offshore Petroleum" (*pp. 46-59*).

Starting in 1974, the all-important questions of offshore leasing and royalty policies have been studied by Professor John W. Devanney III, and this work is represented in this issue (*pp. 38-45*) by a summary of Professor Devanney's report, "The OCS Petroleum Pie."

Sea Grant work on offshore oil continues at M.I.T. A computer model of wave-induced transport of oil slicks, and work on the effect of turbulence to draw polluting droplets from a contained oil slick, should together lead to better spill control, containment, and collection.

Letters

A Neglected Variable?

Thomas B. Reed's thesis that presently collected or collectible biomass in the U.S. could satisfy about 10 per cent of our energy needs (*see October/November, 1975, p. 16*) is the victim of technology's most frequent demon — the neglected variable. Dr. Reed's neglected variable is soil structure.

All soils of agricultural value (except for certain sandy soils) rely on an organic component not only for plant nutrition but also for water retention, workability (tilth), cation exchange capability, porosity, and control of the microscopic flora and fauna.

While you deride those who "plow it under, or leave it to rot in the forests," any dirt farmer (as opposed to corporate farmer) knows that if he stops plowing under some residue, his soil will degenerate into a dense clay incapable of supporting commercial crops. . . . [My] observation as a farmer indicates that the problem is very much the reverse of Dr. Reed's worries. Not *enough* organics are being returned to our crop and timber lands and no amount of genetic manipulation and soluble nutrition is going to rescue our farms from deterioration.

Richard G. Garber
Hood River, Ore.

Dr. Reed replies:

This is another instance where if man cannot control his greed, he will destroy the life-supporting functions of the planet. . . . However, we did learn from the dust bowls of Kansas a lesson which hasn't been repeated. The modern farmer does not seem to be irreversibly destroying his land because he has learned through continued observation and experiment which practices are safe. Our knowledge of these limits is not so fully developed for intensive forestry, but Mr. Garber and many others are at least aware of the problem.

Farmers have found in many places that removal of much of the residue does foster better growth, depending on the crop, the soil, and the climate. Presumably there is an optimum amount of residue to leave in forest sites, as well; we will only find that optimum by careful tests and observations over many years. Yet cellulose is so resistant to decay that we put chips on the ground to prevent unwanted growth, and in a natural forest leaving all residues will nearly always slow up seeding and rooting. Further, the conversion of waste biomass to methanol or ammonia through partial combustion leaves a residue of ash that could be immediately returned to the land in the best form. Intensive agriculture and forestry yield profits which can support proper research into land care. For those that like to be in the forefront of worry, I recommend worrying about phosphorous depletion as the end of our world.

Although I second Mr. Garber's warning to be careful, I am sure we can harvest wood and biomass as a major source of energy without ultimate destruction of the land — provided we are prudent.

New Way to Skin a Cat

Drs. Naill, Meadows, and Stanley-Miller argue that total U.S. demand for oil and gas can be satisfied by only two sources: conventional oil and gas wells, or conversion of coal and oil shale to synthetic fuels (*see "The Transition to Coal," October/November, 1975, pp. 18-29*). I believe the premise "ain't necessarily so."

Dr. Diesel set out to approximate the Carnot cycle but achieved only compression ignition, and left combustive processes in a shambles. His goal of using powdered coal was not reached, although the air injection of fuel oil had a short ascendancy in marine applications (the common rail concept) before proving impractical. The current use of 10 to 12 gear ratios for truck operations (inferior torque characteristics) is a measure of the failure, and is only one criterion.

It is true that so long as coal is considered suitable only for boiler use (steam to electricity) with combustion at atmospheric pressure, or for processing into oil, it can only be supplemental to oil. Yet if Dr. Diesel's goal is achieved and there is a release from the above limitations, coal will become fully competitive with oil all across the energy spectrum.

Harlow B. Grow
Pacific Palisades, Calif.

Learning to Outgrow

My direct interest in technology is distinctly borderline. Its greatest task is to undo 200 years of mischief. Years ago I took a little extracurricular chemistry at Boston Latin School, meaning to go to M.I.T. and be an architect. I am so glad I

chose Harvard and history instead.

If we survive, someday a public plan of technology will resurrect the precious handicrafts still surviving in odd corners (Maine, for example), and the earth will be disencumbered of all industrial gadgetry except what is licensed for real human and environmental necessities. China's 800 million are showing the way to some extent. "Turning back the clock" to returnable containers (*see "Cutting the Energy in Cans and Bottles," March/April, 1975, p. 52*) is a straw in the wind. The "new" technology, like the really new economics, will be completely rooted in the science of ecology. We shall learn that human maturity is not to grow, but to outgrow.

Lyman Hinckley
San Francisco, Calif.

Fentestic II

According to the *Encyclopedia Britannica,* when Mt. Katmai, Alaska, erupted in 1912, it "liberated into the atmosphere such quantities of hydrochloric and hydrofluoric acid that clothes hanging on lines as far away as Chicago were damaged."

If Mr. Kolb (*see "The Depletion of Stratospheric Ozone," October/November, 1975, pp. 38-47*) would plug some of these figures into his computer, it would tell him conclusively that we all died years ago.

"Fentestic" as Mr. Schneider would say!

Alvin P. Fenton
Oostburg, Wisc.

Dr. Kolb replies:

Mr. Fenton is correct in noting that volcanoes can produce copious amounts of acid gases including HF, HCl, and H_2SO_4. The possibility that volcanic emissions are a significant source of stratospheric chlorine was under investigation even before the freon source was postulated. Recent estimates of stratospheric chlorine input from volcanic sources have been made by R. Cadle of the National Center for Atmospheric Research and R. Cicerone of the University of Michigan. Their estimates of volcanic Cl entering the stratosphere are 28,000 and 10,000 to 30,000 metric tons (1 metric ton = 2,200 lbs.) per year. This can be compared with the Cl input from the freons, CF_2Cl_2 and $CFCl_3$, which is currently estimated to total 500,000 metric tons per year. Volcanoes do emit more HCl than the roughly 30,000 ton stratospheric input figure indicates, but most of it is absorbed by water droplets and rains out before reaching the stratosphere. In fact, Cadle estimates that only about four per cent of the HCl due to volcanoes penetrates the tropopause. It is the remaining 96 per cent that ate holes in the clothes noted by Mr. Fenton rather than eating holes in the ozone layer.

A Volvo Superfactory?

I read with interest D.M.'s "On the Line at Volvo" (*December, p. 17*). In particular, the report that the Kalmar factory has reached "its full quota of 30,000 Volvos per day" must carry some hidden message. Has Detroit really moved to Sweden? Come now, D.M., let's have some accuracy, if only to an order of magnitude.

Kenneth R. Wadleigh
Cambridge, Mass.

Mr. Wadleigh is Vice President and Dean of the Graduate School at M.I.T. He is correct; the figure should have been 30,000 Volvos per year, which will be neatly doubled soon when the Kalmar plant adds a second shift of workers. — D.M

Let Technology Flower

The entire thrust of your June issue (*"Materials: Working with Shortage"*) seems unduly pessimistic. I remember the statement in the late 19th century by some U.S. official that America was doomed because by 1940 all U.S. agricultural land would be required to support the draft animals needed for such a large population. It is my opinion that, if we can shake off the national paralysis that has gripped the nation since the Vietnam debacle, we could within a five- to ten-year period be commercially producing solid-state solar conversion devices that would generate so much electricity at such a low cost that we could extract metals from very-low-grade ores — possibly even from rock and sea water.

Franz Zrilich
Hinckley, Ohio

Management and Labor: Unite!

Jerome B. Wiesner returned from a visit to China with a hypnotic experience and a puzzling question: How can the Chinese manage their society without managers? (*July/August, p. 8.*) Since this question seems to bother Dr. Wiesner as well as other thoughtful American visitors, I would like to make a few comments.

It is true that China has no privileged managerial class, nor do Chinese universities offer "management science" as an academic discipline. Nevertheless, management functions are being performed there. But there are basic differences between their management-style and management-techniques and those to which we are accustomed. In this country, management and labor regard one another as adversaries, more or less, despite what management consultants may say. In Japan, as is now well known, management takes a paternal attitude toward labor. In China, they strive for proletarianism. How does proletarian management work? Certain patterns are discernible.

To manage manual labor, they rely heavily on the technique of setting examples and making demonstrations. When a Chinese worker sees his leader planting rice or digging coal right beside himself, he wants to work harder. This is why party cadres, military commanders, and government officials consider it their duty to participate in manual labor at regular intervals. If a commune decides to introduce multiple cropping or a new strain of wheat, its management team (called revolutionary committee) would set up demonstration farms to show members of the commune what to do and how to do it. If a factory decides to introduce numerically controlled machine tools, they too are demonstrated.

One of the important management functions is planning. Here the Chinese system differs fundamentally from the Russian approach. In the Soviet Union planning is centralized; its structure is from the top down like a funnel. The Chinese emphasize local planning with the central government serving only a coordinating function. Its planning structure is more like a pyramid. This is probably the main reason that Chinese production quotas are seldom missed; they are often overfulfilled.

Managing mental labor (or sophisticated physical labor) is more difficult, and the methods used must be more subtle. I believe this statement is as true in a socialist country as in a capitalist one. Here again certain Chinese patterns are discernible. Following the item about the Wiesners' trip is an account of earthquake research in China. Obviously, Chou En-lai did not tell the Chinese scientists how to make earthquake predictions. But he gave them ample financial and moral support. The Chinese government also made clear its view that "earthquake prediction manifests the concept of science for the people." The result? The Chinese have been able to predict a major earthquake more than a year ahead of time.

Last May, a Chinese team of one woman and eight men succeeded in scaling Qomolangma Feng (Mount Everest) from its north slope. Although non-Chinese climbers had reached the peak earlier, they had done so from the easier south slope. To encourage the explorers, the Central Committee of the Chinese Communist Party sent to them, by special plane, a load of fresh fruits and vegetables. The team probably would have succeeded without the fresh produce. But this small gesture indicates to me that they must have received the full range of management support.

Schistosomiasis (snail fever) is an infectious disease that used to afflict large numbers of rice farmers, killing many of them annually. Several years ago a group of medical workers discovered an effective vaccine against the disease. When news of the discovery reached Chairman Mao Tse-tung, he got so excited that he could

(*Continued on p. 71*)

The Importance of Improbable Events

Technology/Society
by
Kenneth E. Boulding

As one contemplates the universe, spread over billions of light-years in space and millions of years in time, improbable events assume an importance which they lack when we survey realities nearer to hand. In the study of evolution or even the history of the human race, events which are improbable from day to day become more likely. That which has a probability of one per cent in a year, such as a 100-year flood, has a 66 per cent chance of occurring in 100 years and 99.99 per cent chance of occurring in 1,000 years.

Because we have difficulty grasping the exponential accumulation of probabilities with time, we tend to underestimate the importance of improbable events. We cannot account for them within the limits of our time and space.

Dealing with Risk

We make our decisions, and quite reasonably so, by regarding a very small probability, for all practical purposes, as zero. We all know when we take a plane that there is a certain small probability that we won't come back, but the probability is so small that we ignore it.

At the other end of the scale, the occurrence of an improbable event distorts our perception of its probability. Hitler may well have been history's equivalent of a 1,000-year flood — that is, an improbable event which came off. But nonetheless, the "Munich trauma" has dominated international politics for a generation, at very considerable cost in terms of unnecessary armament and cold war.

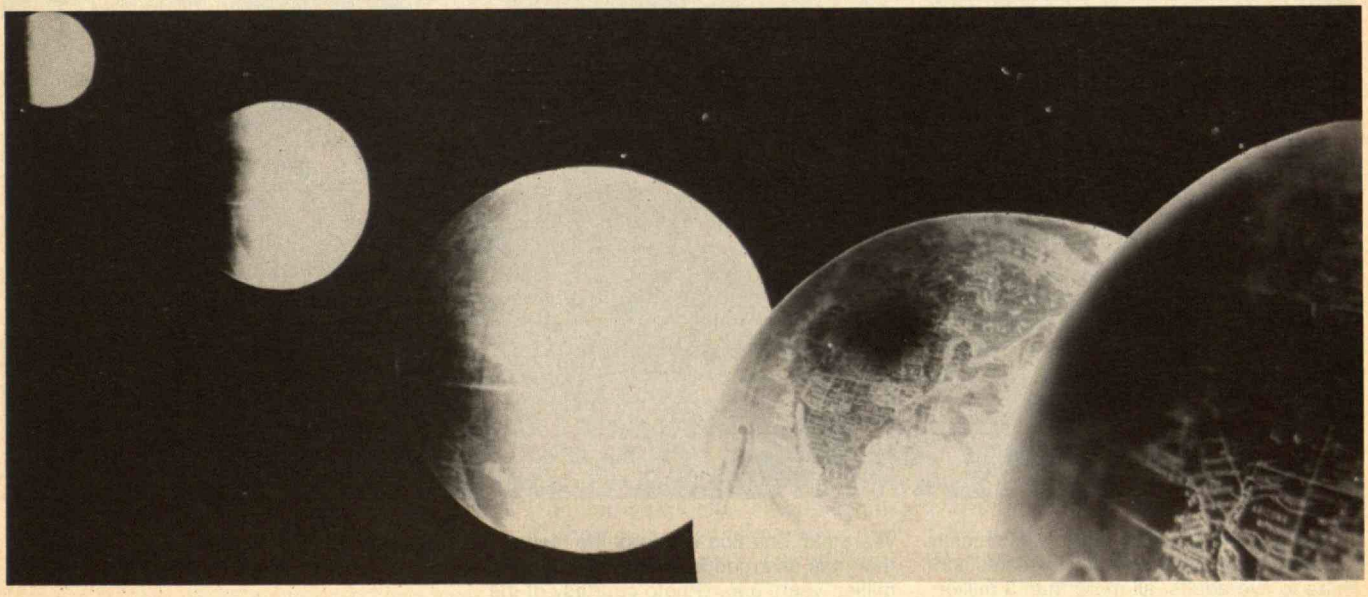
The problem of dealing with the improbable becomes particularly acute when decisions must be made which have consequences beyond the span of responsibility or even life of the decisionmaker. The problem is even more difficult when it involves failure to decide — what I have called a sin of omission. We know that San Francisco will be destroyed in x years. There is a fair chance that x is less than ten and a virtual certainty that it is less than 100. Although most of the citizens of San Francisco simply dismiss the possibility from their minds, they know deep down that the San Andreas fault is waiting for them and that California's absurd geological ambition to reach Alaska is relentless and unremitting. Something probably can be done about it. Building codes can be strengthened and enforced. Research on the lubrication of faults may enable us to substitute a lot of small earthquakes for one big one. Earthquake prediction may not be far off. Plans for orderly evacuation certainly can be prepared, and so on. Will the next generation say that we left undone those things that we ought to have done?

Terrible Certainties

The nuclear strategy of maintaining large numbers of missiles for deterrence is a system with a San Andreas fault underlying it. It cannot be stable in the long run; otherwise it would cease to deter. But because the system is stable in the short run, we do not explore ways to change it and so lower the probability of perhaps irretrievable disaster. The proposition that unless the international system is transformed, the whole temperature zone will be destroyed in x years is almost as certain as the proposition that an earthquake will destroy San Francisco. And again, we do not know the value of x. It is almost certainly greater than ten, and almost certainly less than 200.

The probability of demographic catastrophe has until recently seemed very small. Yet Bangladesh is almost exactly the size of Iowa and has 77 million people to Iowa's 2.8 million. By the year 2000, the population may rise to 135 million. If we imagine Iowa with 135 million people

(*Continued on p. 71*)



Tracing the Ascent of Man

National Report
by
David F. Salisbury

Francois Bordes teetered on the folding chair as his arm swung upward. With a powerful stroke, the noted anthropologist brought the rock, tightly clenched in his fist, down on the edge of a piece of volcanic glass which he held clamped against his leg.

With a loud "crack," a chip of the black glass flew across the room and Dr. Bordes grunted with satisfaction. An expert on Paleolithic toolmaking, he was demonstrating how man must have made stone tools as early as 2 million years ago.

Dr. Bordes is Professor of Prehistory at the University of Bordeaux in France. He says he spent ten years of trial and error before he could fashion stone into tools instead of breaking the rock into useless fragments. Tools are important to many anthropologists as one of the most basic signifiers of early man.

As It Was in the Beginning

Two-million-year-old stone tools have been found in the Great Rift Valley near Lake Rudolf in Kenya and in the Omo valley in Ethiopia, but just who shaped them is a mystery. The problem is not lack of evidence, but rather its variety. The fossil remains of human-like beings (*hominids*) show a surprising diversity, and their interpretation is hotly contested within the small, international coterie of paleoanthropologists.

Yet, gaining support among the experts is the belief that more than one type of *hominid* lived contemporaneously in East Africa more than 2 million years ago, and perhaps more than one type made stone tools.

Until recently, virtually all of the evidence to support this theory came from excavations near Lake Rudolf in Kenya. Richard E. Leakey, son of noted anthropologists Mary and the late Louis S. B. Leakey, directs those digs and has been the leader in espousing this radical new interpretation of the fossil record. If Mr.

The desolate Afar region of Ethiopia recently yielded the fossil remains of two infants and three to five adults, all more than 3 million years old. The find supports the theory that man diverged from ape as early as 10 million years ago. (Photo courtesy of the Cleveland Museum of Natural History.)

Leakey is right, the early toolmaker responsible for the stone artifacts might be envisioned as strikingly manlike (*homo*, or true man). Alternatively, he could have had a small, apelike head perched on a small, but very human body (*homo habilis* or *australopithecine habilis*). Or, less favored, he may have appeared a larger and less human-looking apeman with beetle brows and a small brain (*australopithecine boisei*).

At a conference at New York University over a year ago Mr. Leakey, who is Director of the Kenyan National Museum, said, "There seem to be three distinct types of creature at Lake Rudolf. Call them thing A, B, and C if you like."

The first of Mr. Leakey's "things" is best illustrated by a shattered skull found at Rudolf in 1972. Skull "1470" is large-brained (about 800 cubic centimeters) and dated at 2.8 million years. Its size is comparable to that of *homo erectus*, which first appears 1 million years later. *Homo erectus* is the earliest indisputably true man.

Curiously, the 1470 skull appears even more modern than that of *homo erectus* in some respects. And according to Henry M. McHenry, Assistant Professor of Anthropology at the University of California at Davis, the leg bones found in association with this skull are also much more like modern human bones than like other early femurs.

Last October, Dr. Mary Leakey announced a new find in Tanzania. She reported that fossil jaws and teeth from at least 11 different individuals, dated between 3.35 and 3.75 million years old, were found at Laetolil, a site just 25 miles from Olduvai Gorge where Dr. Leakey has worked with her husband for the last 40 years. These teeth resemble some found with the 1470 skull at Rudolph, Dr. Leakey announced.

The Laetolil teeth also resemble some found in the Afar region of Ethiopia. Here a young American anthropologist, Donald C. Johanson, and a French geologist, Maurice Taieb, are working what many experts consider to be the most exciting new site in years.

Just before Christmas, from Addis Ababa, Drs. Johanson and Taieb announced they had unearthed the fossil remains of two infants and three to five adults, more than 3 million years old. Dr. Taieb is with the National Center for Scientific Research in Paris. Dr. Johanson, Assistant Professor of Anthropology at Case Western Reserve University and a curator of the Cleveland Museum of Natural History, thinks the remains are of *homo*. He says that one was quite large, "approaching the height of modern man." One nearly complete hand is almost modern in size and probably capable of fine, precise movements, the anthropologist reported.

Can You Imagine?

Details of both the Laetolil and latest Afar finds are very sketchy. But taken at face value, both give added weight to the theory that several types of manlike creatures, and only one true *homo*, coexisted for several million years, and that the human line diverged quite early, perhaps as long ago as 10 million years.

Still more support comes from Java. There, G.H.R. von Koenigswald, Curator of Paleoanthropology at the Senckenberg Museum in Frankfurt, has found three distinct types of hominids in sediments at least 2 million years old. These he calls *typical homo, meganthropus*, and *pithecanthropus dubious*. *Meganthropus* is similar to the robust *australopithecines* found in Africa. And *pithecanthropus dubious* bears at least a superficial resemblance to *habilis*.

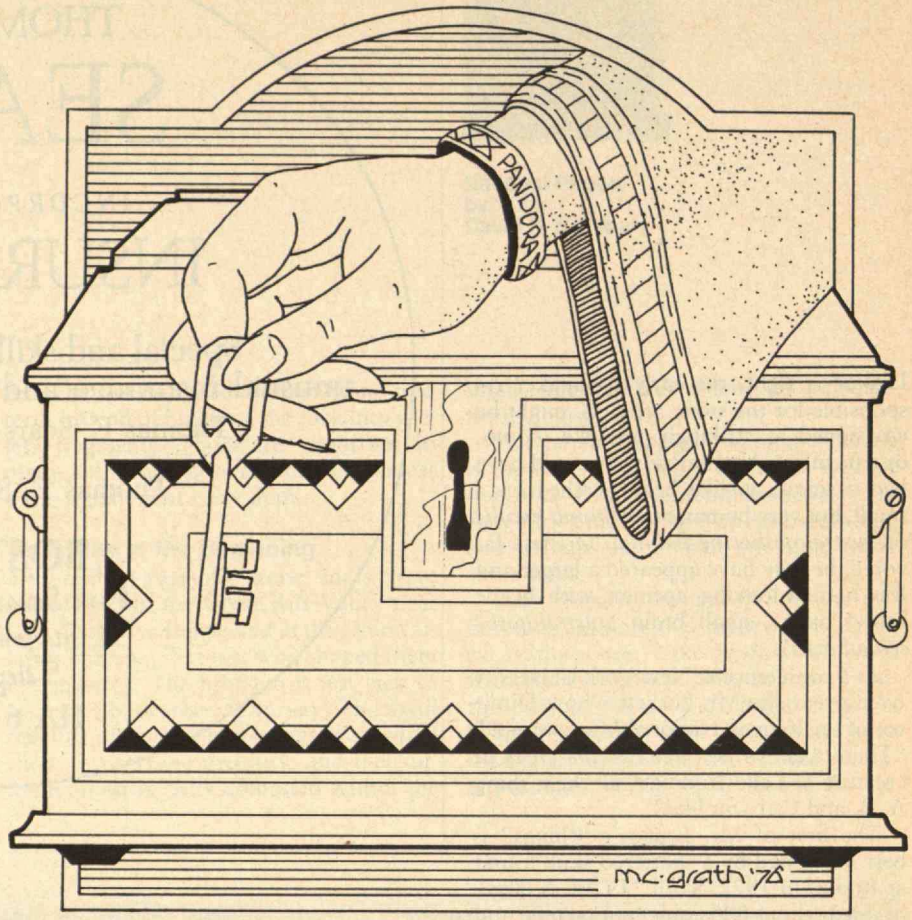
"There is no doubt we have *australopithecine* next to *homo*," says Dr. von Koenigswald. He claims one of his *homo* skulls is a striking match for 1470, similar in shape and with a capacity of between 750 and 900 cubic centimeters, depending on reconstruction.

As persuasive as this theoretical history of man's descent may seem, it is all based on the painstaking analysis of frightfully few fossil bones. And there is no agreement on what criteria distinguish man from beast. To some, such as Dr. von Koenigswald, "Teeth are the fingerprints of early man." To others, brain size and shape have final significance. Mary Leakey emphasizes tool-making. And still others argue that man became intelligent only when he could stand upright.

An old friend went into anthropology. When I asked why she had chosen this field, she replied, "You can construct beautiful theories and it is almost impossible for anyone to prove them wrong."

David Salisbury is Science Editor for the Christian Science Monitor *and a regular contributor to* Technology Review.

Genetics and the Common Man



For nearly two years, scientists have engaged in a painful, and perhaps unprecedented, attempt at self-regulation. Using only the force of moral authority, a group of geneticists has succeeded in placing a prolonged, voluntary embargo on most uses of a technique for manipulating genes from living organisms.

The embargo is particularly remarkable since the technique could help unravel a variety of genetic puzzles and eventually lead to important developments in medicine and agriculture. This is believed to be the first time, in fact, that scientists have initiated controls on an evolving area of research, before public pressure has forced restrictions from outside.

So it may seem curious to suggest that this painful attempt at self-regulation suffers a basic defect: lack of public participation. But that charge is being raised, with some justification, by a group of scientists from the Boston area known as Science for the People. Their complaint highlights an important consideration in scientific research policy.

Some Frightening Hazards

The story has been much in the news. The genetic manipulation technique uses a newly discovered class of enzymes to rearrange genes from living organisms in combinations which are unlikely to have occurred through natural evolution. The technique's utility is that it enables genes to be taken from virtually any organism and transplanted into a virus or bacterium whose reproductive machinery copies them.

The process is thus a simple means to multiply and study genetic material from plants and animals, including man, in a relatively uncomplicated environment. But it also involves some frightening, albeit speculative, hazards.

One worry is that a bacterium or virus bearing genes transplanted from another organism may be unpredictably virulent or possess other unforeseen properties. In the worst imaginable instance, a novel epidemic could be loosed. And such fears are heightened by the traditional use of a common gut bacterium, *E. coli,* as the host for the transplanted genes.

Those possible hazards inspired discussion in the scientific community in 1973. In July, 1974, a committee of the National Academy of Sciences, headed by Paul Berg of Stanford University, issued the unprecedented appeal for a voluntary moratorium on various uses of the technique until the hazards could be assessed and regulations worked out.

That call was followed by a now-famous meeting in Asilomar, Calif., at which an international group of some 140 geneticists discussed the hazards associated with genetic manipulation and set guidelines under which most of the research could be resumed. The conference recommended that the moratorium be maintained for many uses of the technique until strains of host bacteria, crippled by simple genetic mutations so as to be incapable of surviving outside the laboratory, were constructed. The group expected that such crippled strains could be produced and made available very quickly.

After the Asilomar meeting, a 14-member science advisory committee of the National Institutes of Health took center stage. Chaired by DeWitt Stetten, Jr., N.I.H. Deputy Director, the committee was formed to transcribe the Asilomar guidelines into regulations governing the support of genetic manipulation experiments by N.I.H.

Two factors made its work enormously difficult. First, the crippled strains which seemed so easy to produce at Asilomar proved elusive. It was not until the end of 1974 that a promising bacteria was constructed, and the moratorium has thus been prolonged. Second, many geneticists made known to committee members their feelings that the risks had been overstated and that the hazards were extremely remote.

The committee consequently had a tough time writing acceptable regulations. Last July, it produced a draft report which, in some key respects, was demonstrably weaker than the Asilomar guidelines, and which met a storm of criticism even before it was published. That criticism led the committee to another meeting, held in La Jolla early in December, at which it finally drafted regulations even stricter in places than the Asilomar guidelines. That draft is likely to be accepted by N.I.H. as the basis for its support of gene transplant experiments.

The advisory committee suggested that some types of experiments — such as transplanting antibiotic resistance genes into bacteria which do not now have them — should be outlawed entirely, and that

Washington Report
by
Colin Norman

most others should be conducted only under strict safety conditions and with crippled strains of bacteria. Since such strains were then undergoing final testing, the effect of the regulations was to suggest that the moratorium should be lifted.

Popular Science

Perhaps most surprising is that both the Asilomar conference and the N.I.H. committee resisted the pressure to write lax rules, and ended by recommending controls which are generally perceived as at least strict enough to protect public health.

The fact that the review was conducted by scientists had certain advantages. The favorable press comment, for example, has gone some way toward repairing the public image of the scientist as a person having little regard for the consequences of his research. It has also considerably heightened awareness within the scientific community of the dangers associated with genetic manipulation, and led to the novel concept of biological containment (use of crippled bacteria) — a solution which could only have come from scientists.

The proposed regulations, moreover, are certainly strict enough to draw the sting from the criticism, raised by the Science for the People group, that the process was like the tobacco industry regulating itself. In fact, one researcher who has been using the genetic manipulation technique, Dr. Donald Brown of the Carnegie Institution, has suggested that the proposed regulations are so strict as to be totally irrational. Dr. Brown believes the N.I.H. committee had to write stringent regulations because it consisted solely of scientists — anything less than draconian would have seemed self-serving.

Nevertheless, it's difficult to deny the validity of the argument that since the public will bear the consequences if the hazards associated with the technique become reality, the public should be involved in setting controls on the research. Senator Edward Kennedy, whose chairmanship of the Senate Health Subcommittee places him in a pivotal position in such matters, has said that the issue is too important to be left solely to scientists. He would presumably be more than willing to insure some public input into the process, possibly even by legislation.

For those reasons, N.I.H. Director Donald Frederickson has devised a sound process for insuring at least a measure of public participation before the regulations are cast in final form. He has called a two-day open meeting to hear the views of many diverse groups, including the Science for the People group, and on the basis of their comments he will decide whether the regulations should be adopted as they stand or be changed. Though it could be argued that public input should have come at an earlier stage, the meeting should at least preserve the technique from being regulated by legislation or other uninformed means.

There is, moreover, one other important stage at which the public should be involved in regular use of the technique. When the regulations are eventually adopted, each institution will probably be required to establish a committee to insure that genetic manipulation experiments are carried out in a safe manner. Those committees should include technicians, laboratory secretaries, and other people likely to face the hazard. Those committees will be key links in determining whether the regulations will succeed.

Colin Norman is Washington Correspondent for Nature *and a regular contributor to* Technology Review.

Breathless: Animals, Humans, and Cigarettes

Technology/Environment
by
Ian C. T. Nisbet

If a chemical is known to increase tumor incidence in mice, it may or may not be likely to do so in humans. And assuming that the chemical does increase tumor incidence in man, we may or may not be able to use the magnitude of the effect observed in mice exposed to high doses to predict the magnitude of the risk in humans exposed to much lower doses.

In a typical carcinogenesis bioassay, a test population of 200 mice is exposed to a chemical and compared with a matched control group. If a small effect is observed — say, ten excess tumors in the treated group — one faces problems involving both qualitative and quantitative extrapolation. In the bioassay, ten excess tumors in 200 mice is about the smallest statistically significant effect; yet we would be concerned about an agent that might induce as few as 10 million excess cancers in 200 million people. It is sobering to consider that each mouse utilized in a safety test is serving as a surrogate for a million people.

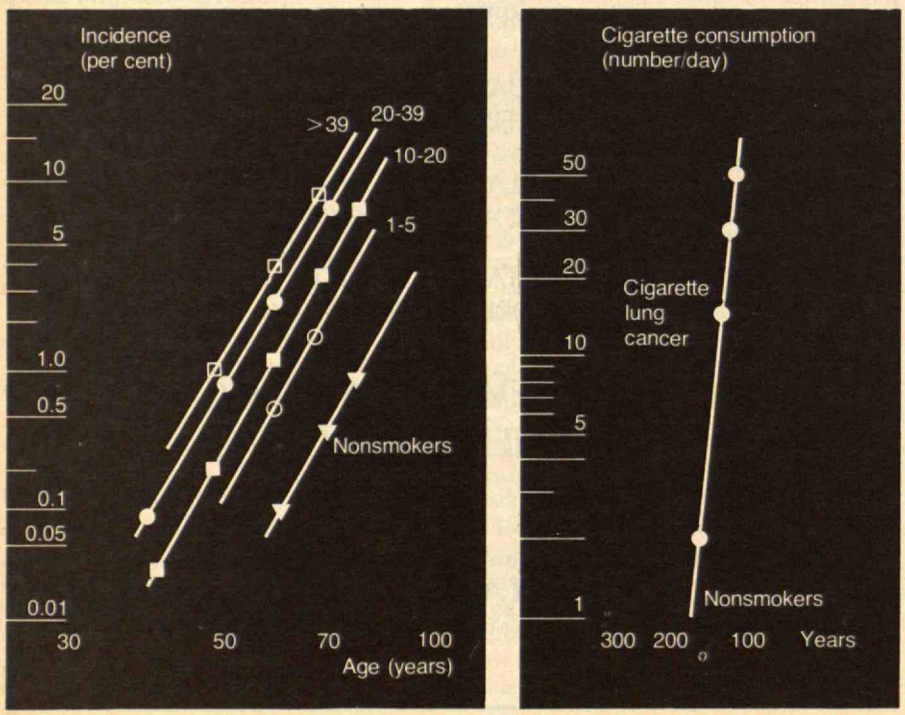
An Ideal Experiment

Given unlimited time and money, one could design an ideal experiment in chemical carcinogenesis. The experiment would utilize a species closely similar in physiology to man; it would involve millions of animals divided into test groups according to degree of exposure, sex, and genetic strain; and it would extend over several generations, with unexposed controls begun at appropriate times. The animals would be observed for their entire lifespan with age and cause of death recorded for each individual. Subsidiary experiments would remove groups of animals from exposure at various ages, and would expose other groups to different carcinogens to test for synergistic effects. With good results, the agent under test would induce more than one type of cancer, including at least one that is rare in unexposed controls.

In fact, such an experiment is in progress. The experimental species is man himself; hundreds of millions of individuals are subjects, and the carcinogen is cigarette smoke. Viewed rigorously, the experiment has flaws: cigarette smoke contains not one, but a number of carcinogens; the subjects' exposure has not been recorded carefully; most of the controls have had some exposure; and smoking has other major life-shortening effects. Yet these flaws are substantially offset by the large size of the exposed population, the careful recording of mortality data, and the detailed information on dose/response relationships. Smoking-induced lung cancer is already one of the best studied examples of environmental carcinogenesis, and with well designed prospective studies now under way, it will, unfortunately, continue to provide a rich harvest of scientific information for at least 75 years to come.

Everything Is Relative

One of the most interesting features of the data on smoking-related cancer is that they manifest several quantitative relationships already known from animal experiments. When a group of mice, for example, is constantly exposed to radiation or to a chemical carcinogen, the times of appearance of the induced cancers generally conform closely to a lognormal frequency distribution. That is, the cumulative incidence of cancers, when plotted on logarithmic-probability paper against time of exposure, usually displays a



Everyone faces a greater risk of lung cancer as they grow older; that risk is proportional among smokers and nonsmokers. But, according to the figure on the left, while nonsmokers' chances are only 0.1 per cent at age 60, the risk for people who smoke a pack a day is 30 times greater (the number of cigarettes smoked each day is shown at the top of each curve). What's more, the figure on the right shows that latency is only weakly dependent on dose, so that lung cancer in the light smoker develops at roughly the same time as in the heavy smoker. (Figures reprinted from *Radionuclide Carcinogenesis*, A.E.C. Symposium Series, 1973, pp. 238, 239.)

straight-line relationship. The same relationship emerges when the incidence of human lung cancers is plotted against age, within a group having similar smoking habits. Yet the slope of this incidence/time curve is much shallower for humans than for most experimental animals. So the human population appears to be much more susceptible than the animal populations usually studied: proportionately, more humans respond very early.

There are also quantitative relationships between dose rate and the incidence of cancer at any given age. In animal experiments, dose/response curves are usually nonlinear, rising steeply above an incidence of a few per cent. The same type of relationship occurs in human lung cancers, although at lower doses the dose/response curve is consistent with a straight-line relationship.

Yet another quantitative relationship has been observed between time of response and dose. Animal experiments with both radiation and chemical carcinogens suggest that the higher the dose rate, the shorter the latent period. But in human lungs, the latent period is only weakly dependent on dose. This again tells us something about the range of susceptibility in humans: the more susceptible part of the population responds in roughly the same time over a broad spectrum of dosages.

Finally, mice and men evidence a relative susceptibility to the same carcinogen. Very recently, lung cancer has been induced in mice by inhalation of cigarette smoke. And a comparison of the total amount of smoke inhaled during a lifetime, based on total cigarettes per unit of body weight, suggests that the susceptibilities of mice and men are similar. Although it is questionable whether the data are strictly comparable on a numerical basis, at least there are no quantitative discrepancies.

No Thresholds

What do these relationships tell us about other carcinogenic hazards? Most significant is the low-dose end of the dose/response and dose/time curves, since human exposure to most environmental carcinogens is much less than can be investigated in experiments with a few hundred animals. The human lung cancer data can be plotted down to an incidence well below 0.1 per cent, with no indication of a threshold dose. Indeed, the data are consistent with a linear dose/response relationship at the lowest dose rates. There is, in fact, some theoretical promise of such a relationship at the lowest doses, since a small percentage of nonsmokers are victims of lung cancer, presumably through their exposure to other inhaled carcinogens. So even if a threshold dose exists for lung cancer, nonsmokers have already exceeded it. Given the hypothesis that the effects of smoking and these "background" carcinogens are additive, one would expect a small incremental increase in dose to produce a proportional increase in response.

It is sometimes argued that since the latency period decreases as dose rate rises, all cancers induced at very low doses will be postponed beyond a human lifetime. But, unfortunately, some human cancers are so potent that this effect provides little protection at low dose rates. More to the point, the *median* time for development of lung cancer even in heavy smokers is over 100 years. Yet the most susceptible indi-

(*Continued on p. 71*)

An Institute Informant

The Editors' digest of recent and current concerns at the Massachusetts Institute of Technology

Research Notes

A Mold That Skips a Phase

Plasmodium, an acellular slime mold, is supposed to exist in three phases during its life cycle. But M.I.T. biologists are intrigued by a form which skips one stage of the cycle, going directly from spores to plasmodium without an intermediate amoebic stage. It's rare — and exciting — to find such an organism, and Professor Charles E. Holt III, wants to find out how it works. He thinks this could help answer the fundamental question of cell differentiation: How does a cell containing all the genetic information for an organism know which information to use and which to ignore?

Swelled Atoms for Atomic Research

When an atom absorbs enough energy, its outermost electron moves outward to an orbit extraordinarily distant from the nucleus; the result is an unusually large atom — a fragile projectile that can hardly miss its target unless it degenerates or gives up its extra energy first. Daniel Kleppner, Professor of Physics in the M.I.T. Research Laboratory of Electronics, has now built a machine in which atomic beams are irradiated by two lasers which push outer electrons out to as far as the 50th possible orbit; the mammouth atoms are more than 2,500 times the diameter of normal atoms. Professor Kleppner's idea is very simple: if your target (an atom) is small, use a big projectile.

A "Permanent" Television Image

A cathodochromic tube is to a television tube what a still camera is to a movie camera; while the picture on the cathode ray tube used in a television set must be regenerated every fraction of a second — hence the picture can be made to move — the image on a cathodochromic tube is permanent — until deliberately erased. Now M.I.T. has applied for patents on what promises to be the best cathodochromic tube yet devised, the work of Lee T. Todd, Jr., of the University of Kentucky when he was a graduate student in the Crystal Physics Laboratory of the Center for Materials Science and Engineering. Dr. Todd's work included the development of a new class of luminescent cathodochromic materials, at least one of which has greater sensitivity and higher contrast than any predecessor, and the design of a projection tube in which to use (and erase) them.

The Year-Round Cranberry

Most of us associate the cranberry harvest with fall frosts — and cranberry sauce with Thanksgiving and Christmas feasting. But cranberry growers would like a more universal image — cranberries a popular fruit year-round, and processing plants working throughout the year instead of just in the post-harvest weeks. To preserve unprocessed cranberries at a cost less than freezing, the M.I.T. Department of Nutrition and Food Science now recommends storage as a coarse puree, seeds and skins included, at a temperature of 40°F. Ocean Spray Cranberries, Inc., sponsor of the work at M.I.T., will use the puree as a source for juice and sauce made and marketed in the off-season.

Protein Instead of Sugar

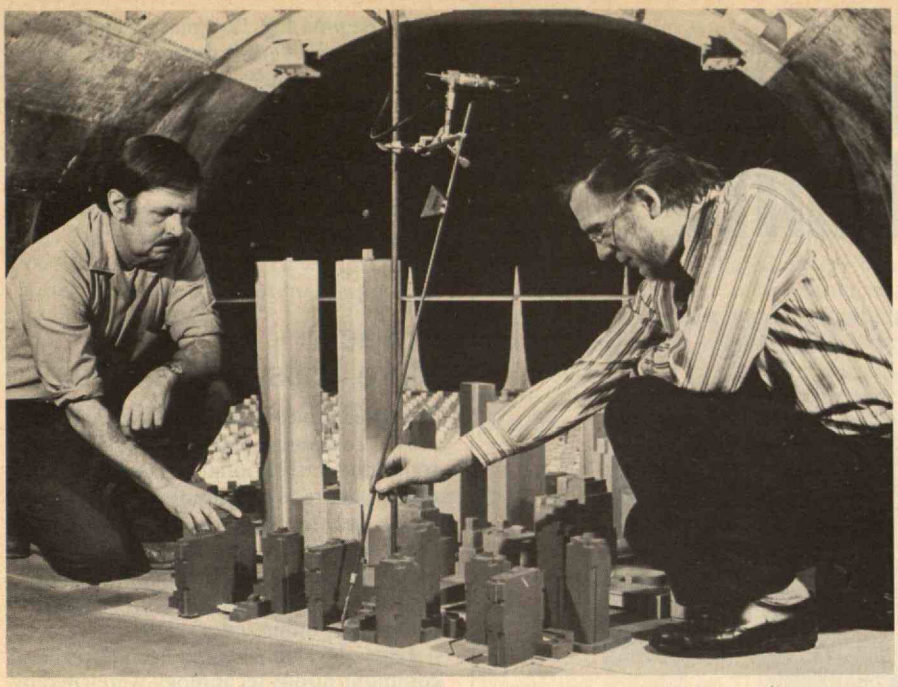
Infectious illness usually causes loss of body protein, and the deprivation can be serious if the infection is persistent. But a diet combining protein, vitamins, and minerals — providing 400 to 700 calories a day, it was used as a reducing diet in the M.I.T. Clinical Research Center — protects patients against protein loss and should displace the alternate treatment: a diet enriched with sugar water, with the body supposed to burn the sugar instead of body protein for energy.

Vitamin A vs. Cancer

The epithelium lines the nasal passages to the lungs, working to trap and eject poisons and impurities in the air we breathe. Vitamin A is necessary for its effectiveness. Hence the postulated link between Vitamin A deficiency and lung cancer: when the epithelium is ineffective, cancer-causing impurities slip down the nasal passages and into the lungs. Is there a similar role for vitamin A in preventing cancer of the colon? Dr. Paul M. Newberne, Professor of Nutritional Pathology at M.I.T., was testing the effects of vitamin A in the presence of carcinogens in rats when he discovered a correlation between colon cancer as well as lung cancer. Studies are continuing to confirm the effect, explain it, and perhaps harness it for the control of cancer of the colon, the most rapidly increasing form of cancer in the U.S.

Separating Cells Electrically

A high-resolution system to separate cells into more than 100 different fractions according to their electric charge has come from the M.I.T. Department of Nutrition and Food Science. One reason among many for seeking this way of differentiating between cells: it promises to be especially effective for isolating a subpopulation of lymphocytes (white blood cells) that attack malignant tumors. Scientists need pure samples of this subpopulation to study its effects — and perhaps ultimately for treating cancer patients. Working with this new technique are (*see photo below*) Dr. Ann L. Griffith, Professor Nicholas Catsimpoolas and graduate student Christos Platsoucas all of the Department of Nutrition and Food Science.



The analysis of wind effects in cities is becoming "a multi-disciplinary field in which architects, structural engineers, and aeronautical engineers are working as a team," says Frank H. Durgin, Associate Director of the Wright Brothers Wind Tunnel at M.I.T. The latest example is this 1: 600 model of lower Manhattan in the wind tunnel to study wind effects at pedestrian level in the proposed Battery Park City development on the edge of the Hudson River. The idea of the Battery Park City Authority — sponsors of the work at M.I.T. — is to use wind tunnel data to design the project so as to minimize "windy areas that would affect pedestrian comfort," says Mr. Durgin (right). The model in use (one inch equals 50 feet) is the result of about 250 hours of work by Earle H. Wassmouth (left), a member of the Department of Aeronautics and Astronautics technical staff; it's the most detailed that he's ever made.

Iron and Intellect

One of the most comprehensive studies ever made of the effects of simple iron deficiency on children's intellectual performance is now beginning in Cambridge. Ernesto Pollitt, Associate Professor of Growth and Development in the Department of Nutrition and Food Science, will look for correlations between iron deficiency and attention span, memory, and cognitive difficulties in some 400 Cambridge children aged from two to six years. The three-year, $290,000 study is funded by the Institute of Child Health and Development of the National Institutes of Health.

Laser Thermometer

To measure the temperature of deuterium ions in thermonuclear fusion, the Francis Bitter National Magnet Laboratory will build a powerful new laser "thermometer" for the Energy Research and Development Administration. Laser-produced infrared radiation will be aimed at the plasma in a fusion reactor, and the frequency of the radiation reflected from the plasma will be proportional to the plasma temperature. A 200-kw. laser beam is required.

Hospital Radiometer

Can the sensitive radiometers used by radio astronomers to detect tiny amounts of radio-frequency energy from space work to measure the minute temperature and radiation differences that separate healthy from diseased human tissue? It is an appealing idea, because radio-frequency energy travels easily through several centimeters of biological tissue. One obvious goal is to provide an earlier detection of cancer in some forms than other available methods; the same technique applied to locate abnormally cool areas might indicate where blood supply were reduced due to phlebitis or an incipient stroke.

Professors Alan H. Barrett and Philip C. Myers of the Department of Physics are now measuring body emission to determine internal breast temperatures of 30 to 40 women a week at Faulkner Memorial Hospital, Boston, where their collaborator is Dr. Norman L. Sadowsky, Chief Radiologist.

New England Earthquakes

A new network of 60 seismic stations to monitor and analyze earth motions will help geophysicists learn more about the structure and state of stress of the earth's crust in New England. Severe earthquakes were recorded in the Northeast in the 1600s, 1700s, and 1800s, but none since. Crustal structures here are not analagous to those in the world's famous earthquake zones; hence the interest in the new seismic network. A consortium of schools — M.I.T., Boston College, Columbia University, the University of Connecticut, and Pennsylvania State University — will use funds from the National Science Foundation, the Nuclear Regulatory Commission, and the Geological Survey to establish and operate the network.

Recycling Demolition Materials

If buildings cannot be recycled, how about the materials in them? As much as 100 to 200 million tons of materials are contained in buildings razed each year in the U.S., thinks David G. Wilson, Professor of Mechanical Engineering at M.I.T.; included are valuable steel, aluminum, and copper. National Science Foundation funding will make possible a study to determine how much materials from this source are salvageable and to seek new technology to increase reuse.

A Technical School for Iran

M.I.T. has received a five-year $1.5-million contract from Iran's Imperial Organization for Social Services for advisory and research services in support of a new technical school in Shiraz, Iran; this work will be in conjunction with Wentworth Institute and College of Technology, Boston, which will develop curriculum, staff, and facilities under a $1.8-million contract.

Integrated Rapid Transit

A major demonstration project of integrated transit service, including a computer-dispatched dial-a-ride system, will be developed by the Rochester (N.Y.)-Genesee Regional Transportation Authority with financial support from the Urban Mass Transportation Administration of the U.S. Department of Transportation; a 30-month management contract for $1.3 million has been awarded the M.I.T. Center for Transportation Studies, where a pilot-model dial-a-ride system for Batavia, N.Y., was designed in 1971 and dial-a-ride service for a 10-square-mile area of Rochester itself in 1973.

Nuclear Medicine

The use of nuclear techniques in treating metabolic disorders, bone diseases, and congenital heart disease will be the subject of new research by the Harvard

University-M.I.T. Program in Health Sciences and Technology. Physicians, surgeons, engineers, and scientists will work together on the use of nuclear medical techniques for treating arthritis, disorders of calcium and bone, and heart disease in children. Grants for support have come from the three groups in the National Institutes of Health.

Privacy: More Losses Than Gains

The precarious balance between benign uses of computers and their threats to personal and institutional privacy has been tipped by recent technological developments, and the risks have increased more than the benefits. It is a classic example, says M.I.T. President Jerome B. Wiesner, of "the most serious problem facing the democratic industrial societies."

Four developments in computer and communications technology were cited by Dr. Wiesner in recent testimony to subcommittees on constitutional rights and science and technology of the U.S. Senate:

— Large-scale integrated circuits continue to lower the cost of computation, with "no obvious limit to this trend."

— Other technological improvements — particularly storage systems which are larger, more accessible, and less expensive per unit of information stored — are yielding more effective computers . . . with greater speed and capacity."

— Software technology is also improving, with a result that larger and more complex machines can be used for information processing.

— New transmission systems capable of carrying vast amounts of information at lower costs "facilitate communication among computers . . . and make possible much more extensive data exchange, information manipulation, and information search."

On the other side of the balance, there has been dramatic improvement in technical safeguards: "There are now available agreed-upon encryption algorithms for the protection of computer information systems which provide a very high degree of security against outside surveillance, if the user is willing to accept the slight extra complexity and cost they involve," said Dr. Wiesner, and he expects them to be used widely.

But "civil rights can only be protected by men — through laws — not by technology," Dr. Wiesner told the Senate, and he believes that additional legal safeguards are necessary. Four years ago, at similar Senate hearings, Dr. Wiesner had listed four actions to provide safeguards of constitutional freedoms: a congressionally-appointed watchdog authority; rigid limitations on surveillance supported by strong penalties; permission for data review or judicial controls; and

new technological research, out of which have since come the new encryption safeguards.

But since then there have been "revelations of extraordinary extent and range of the violations of personal rights of privacy" condoned or even initiated by "the highest officials of the government," and now Dr. Wiesner wants a new element in the safeguard system which would "assure a greater degree of individual responsibility and accountability."

Energy-Saving Advice for Plant Managers

You want to save energy in your industrial building? Here in a nutshell is the recommendation of Lewis A. Felton and Leon R. Glicksman of the M.I.T. Energy Laboratory:

Begin with a carefully orchestrated study that correlates energy input (electric and gas meters, fuel deliveries, etc.) and conditions affecting consumption (weather, volume and nature of manufactured output, etc.) to find out how your building uses energy.

From this you can obtain a scale of energy consumers within the building, rating the share of the total energy consumption used in each building function. In the usual case, about 25 per cent of the total energy consumed will go for "environmental services" — heating, ventilating, lighting, and air conditioning — and the other 75 per cent for production support. A light industry will split more nearly half and half between these two.

Almost always, say Drs. Felton and Glicksman, energy use is most easily manipulated in environmental services, and they offer three simple rules:

— Almost without exception, modern buildings are overlighted. Cut down lighting to the amounts recommended by the Illuminating Engineering Society. (Ninety per cent of the energy drawn by most lights is transformed into heat, so reduced lighting is not so advantageous in winter but has a double advantage in summer.)

— Set thermostats to 68° and lower them further at night and on weekends.

— Raise air conditioning thermostats and reduce internal heat gains by shading windows.

These procedures were tested and proven by Drs. Felton and Glicksman at an all-electric light-industry manufacturing plant (Raytheon Missile Systems, North Andover, Mass.). The result was 24.8 per cent annual energy savings — 12.0 per cent in heating, 7.6 in ventilation, 3.4 in lighting, and 1.8 in air conditioning. The pre-conservation analysis showed that heating required 40 per cent of the plant's energy in an average year; during the heating season, energy need varied by 125 kilowatts per degree F. of outside temperature. The heat loss through ventilation was 1.930 kilowatt-hours per degree-day, and an additional 621 kilowatt-hours per degree-day was lost through conduction; this data made reducing the air change rate "a major objective" of a conservation program.

A better alternative to manual operation of heating, ventilating, and lighting systems to conserve energy, think the engineers, is a computer-based energy control system to manage temperature and ventilation. For a plant with a $1 million annual energy bill, a minicomputer costing $100,000 could pay for itself within a year — and have time left over for other jobs, too. — *J.M.*

Plastics Made Harder and Faster

Two fruits of a cooperative M.I.T.-industry research program in polymers and their processing were announced late last year:

— The dilemma of brittleness vs. hardness has been conquered by a new fiber-reinforced glassy material.

— A new mechanical-electrical hybrid mixing and delivery system promises high-speed production of large polyurethane components.

The historic problem with fiber-reinforced plastics has been to combine toughness and stiffness; a polymer mixed with rubber, for example, would be tough but flexible. In the new material, reported this fall by Professor Nam P. Suh of M.I.T. and Terence J. Jones of Instrumentation Laboratory, Inc., some reinforcing fibers are coated with a viscous material which absorbs the energy of impact; the result is a new material which will make sturdier headgear for construction workers and put new plastics in highway guard rails, car bumpers, and machinery.

The major step in polyurethane molding is mixing together two viscous liquids; they react together almost instantly (in three to five seconds) to form the polymer. Because everything happens so fast, most mixing systems used in the industry are limited to eight to ten pounds at a time. The new M.I.T.-devised system uses two concentric cylinders with an electric field between them to process batches of 30 pounds or more — "a significant breakthrough," says Professor Suh, by graduate students Christopher A. Rotz and Sal C. Malguarnera.

Bright Future in Soils

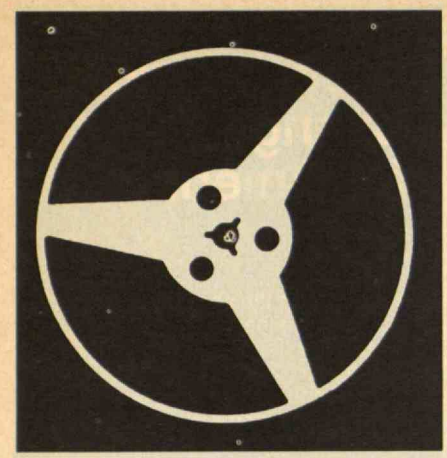
Though people have been setting vast structures in the ground since before the pyramids, geotechnical engineering — the study of soils and the foundations that can be built on them — is far from a mature discipline. Despite countless books and a surfeit of instruments, no two soil engineers will make the same predictions about the performance of a constructed facility and — more often than not — neither one of them turns out to be right.

Geotechnical engineering deserves a leadership place in any list of today's "creative" disciplines, thinks T. William Lambe, Edmund K. Turner Professor of Civil Engineering at M.I.T. The action will be in the good graduate universities and in the small, innovative consulting offices, Professor Lambe tells his students.

At the end of World War II, the universities were the principal sources of innovative work in soil mechanics and geotechnical engineering. They still are "the least worst" places to be, despite the ever-deepening penetration of government, red tape and ever-worsening economic conditions. That's because of the graduate students, thinks Professor Lambe — they "don't believe what you say and will work 80 hours a week to prove it."

The major geotechnical consulting firms of the 1940s and 1950s are trapped in the middle now, says Professor Lambe. They're so big that they tend to lose touch with their clients (people who need soils work now "want to retain an individual, not a faceless company. . . . They want to know who is doing the work"), but they will have increasing difficulty in competing with the "in-house" groups of such leading "turnkey" firms as Stone and Webster and Bechtel Corp.

For the future, Professor Lambe's vision is an engineering office in the image of the medical center — a group of geotechnical specialists who can work together as individuals on the many aspects of a complex problem. They'll increasingly use test instruments to measure conditions in the field — that's the frontier of geotechnical research today, thinks Professor Lambe — and they'll lead the profession to gradually improving predictive methods.



The (18.5-Minute) Credibility Gap: Analyzing the White House Tapes

Move over, Columbo. The technological sleuths have proven that it's not who, but what done it that counts.

The crime: alteration of 18.5 minutes of the June 20, 1972, taped conversation between Richard Nixon and H. R. Haldeman.

The suspects: seven or eight Sony 800 tape recorders, a few other types of recorder, and a lone Uher 5000 with an unusually strong erasing system.

The investigators: six experts in electrical engineering and acoustical science, hand picked by lawyers for both the prosecution and the defense.

This fall three of those experts, Richard H. Bolt, Thomas G. Stockham, and Mark R. Weiss, gave an M.I.T. audience an inside view of the unusual events from the time Judge John J. Sirica asked them to examine the tapes until they presented their final report.

Dr. Bolt did his best to convince the court that he was not the one they wanted before agreeing to study the tapes, he said. But the former M.I.T. professor of acoustics was assured that he, as well as the other five, had been culled from a list of 100 experts, and were the unanimous choices of both the prosecution and the defense. But Dr. Bolt was still reluctant until he obtained assurances that he would be treated as an impartial witness, as well as a guarantee of freedom from interfering censorship. His requests were granted, but the court inserted a Catch-22. Security demanded that the panel not listen to tapes at less than four times normal speed.

"That's like blindfolding an art expert and asking him to identify an oil painting from the back," commented Dr. Bolt.

On November 18, 1973, the panel first met to examine the setup of microphones and tape recorders inside the Oval Office. They found microphones designed for invisibility rather than acoustical integrity, "the kind of thing a spy would wear on his lapel, a long, thin filament attached to a receiving device," Dr. Bolt explained. This type of microphone could not yield a high quality recording. In addition, the several microphones hidden in the President's office interfered with each others' reception, and the reverberation in the room further degraded the quality. For these reasons, the panel agreed that the equipment and its installation could account for many of the inconsistencies in various transcriptions of the tapes. But, despite this explanation, Judge Sirica still believed that the tapes may have been tampered with. So the panel decided upon a procedure to examine the possible meddlings — splices, cuts, erasures, or dubs. Because there was no precedent for such an examination, the panel literally made up their own approach. Some of their original plans were "completely wrong," Dr. Bolt recalled, "and we ended up doing some things we hadn't even dreamed of."

On November 21, 1973, the day the panel was to be introduced to the court, White House lawyers revealed a new fact that changed the focus of the panel's work: an 18.5-minute gap in one of the tapes subpoenaed by the court, the June 20, 1972 conversation between Richard Nixon and H. R. Haldeman, soon after the Watergate break-in.

"Until then we thought we were to determine if the entire set of over 60 tapes was authentic. But after the buzz section was discovered on the one tape we didn't pay much attention to the rest of them," said Dr. Bolt. Judge Sirica was especially disturbed by the gap. "It was Judge Sirica's concern over the possibility of gaps or erasures on the tapes that had originally called the panel into being," Dr. Bolt continued.

More concerned about the mysterious buzz on the gap than about possible security breaks, the lawyers agreed to stop quibbling over the speed at which the panel could listen to the evidence tape, and threw in about 50 minutes of conversation for good measure.

Judging from the 30 seconds or so of conversation that was played to introduce the M.I.T. audience to the buzz, the lawyers seemed over-zealous in their protection of the national security. That bit of conversation referred only to the "soft spot" in Mr. Nixon's heart for South Dakota, where Pat Nixon's parents had lived before moving to Ely, Nevada.

The panel used four basic methods in their sherlocking: critically listening to the tape; looking at magnetic markings on the tape; analyzing electrical signals picked up from it; and measuring the performance of machines on which the speech and buzz were recorded.

No Ordinary Buzz

On December 1, 1973, the evidence tape and seven or eight tape recorders were delivered, with utmost secrecy and all due pomp, to the New York office of Mr. Weiss. He listened repeatedly to the tape, he said, puzzling over what tests to try, and attempting to reproduce the elusive buzz using the same desk equipment reportedly used by Mr. Nixon's secretary, Rosemary Woods. (As the reader may recall, Miss Woods admitted that she was probably responsible for the gap, and offered the explanation that she had mistakenly depressed the foot pedal of the tape recorder while reaching for the telephone.)

After a night of fruitless testing, Mr. Weiss tried to leave his office only to find the place mobbed with reporters. "All I could tell them was 'no comment,' " he said.

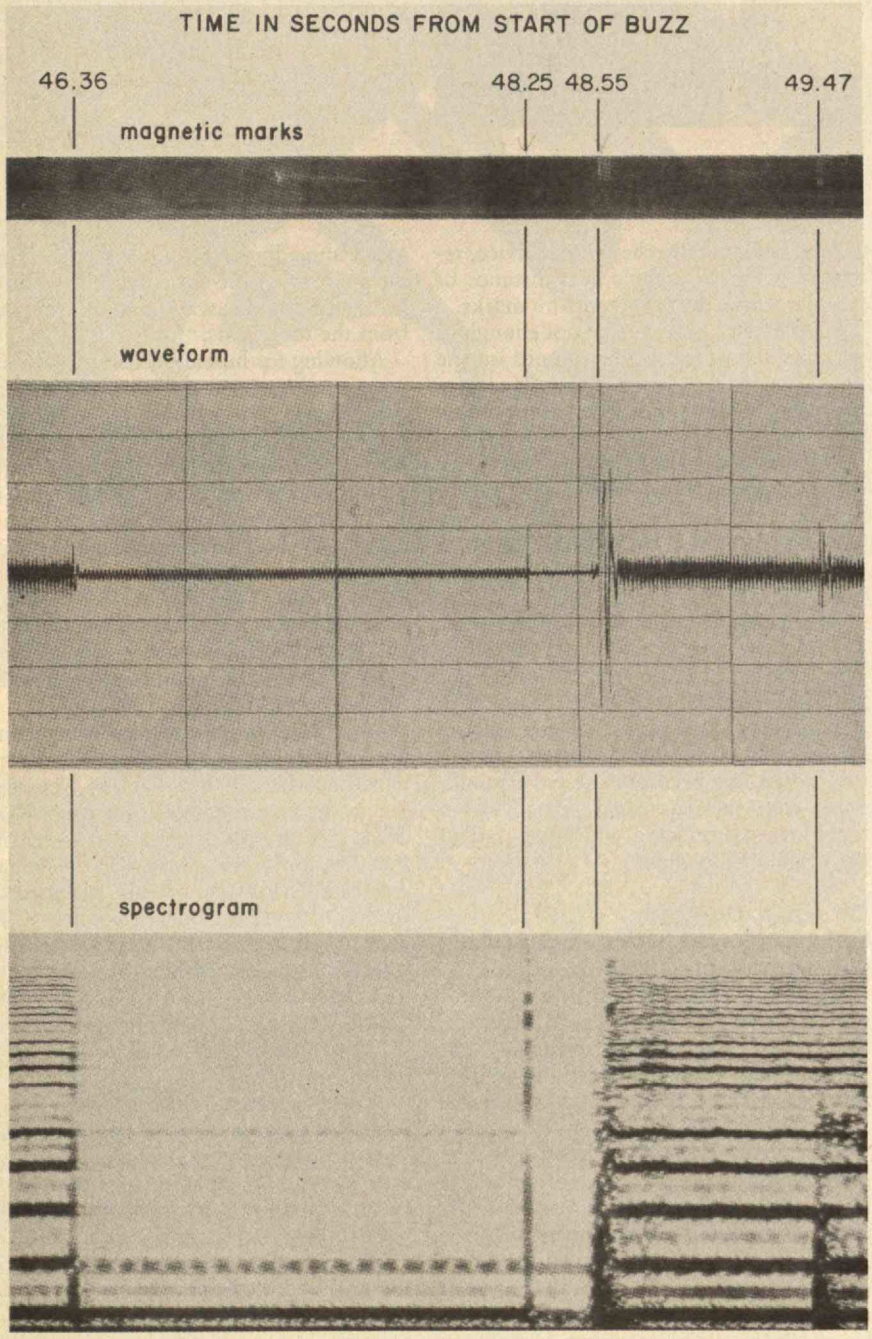
Four days, nights, and dozens of sandwiches later, the panel had their answer: no combination of electric typewriter, high intensity lamp, and tape recorder could have produced the 18.5-minute buzz.

"We had tried all night to reproduce that buzz and got nothing. Then from 8:00 in the morning until 5:00 at night we couldn't get rid of it," Mr. Weiss reported. In reality, the panel found that the occurrence of the buzzing sound was incidental to the erasure and the way the erasure was created. The buzz was merely an electrical disturbance picked up by the tape recorder when the microphone was unplugged and the gain was turned up on the machine.

Proceeding beyond the buzz, the team used a mixture of sophisticated electronic measurement and educated guesses to divine the origins of the underlying clicks, pops, and blurps on the tape. To underscore the hectic nature of the research, the

Special Report
by
Sara Jane Neustadtl

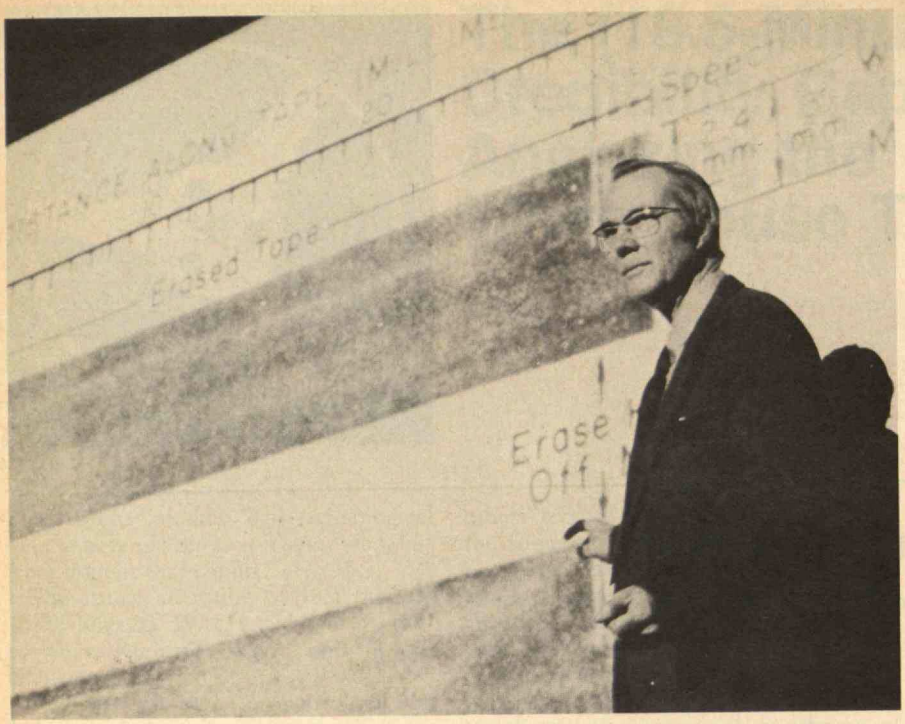
How the 18.5-Minute Gap Was Analyzed



Looking at how magnetic particles collected on the tape told the investigators which tape recorder was used, for each tape recorder leaves its own unique fingerprint of marks. Shown is a section about 48 seconds into the gap.

Oscilloscoping the waveform showed in more detail the occurrences along the length of the gap. Note how the buzz changes along the length of the tape, indicating such tape-recorded functions as stopping and starting.

Spectrographing the buzz fingerprinted the sounds appearing within it. For the spectrograph shown here, each horizontal line is a specific frequency of sound, and the darkness of the line is its amplitude. At the far right of this section of tape, you can see another sound underlying the basic buzz. This is un-erased speech sound, which proved to the investigators that the buzz was recorded over speech sounds, and was not part of the original recording.



Richard Bolt, President of Bolt Beranek and Newman, headed the panel appointed by the court to investigate the Nixon tapes. He reviewed the panel's findings for an M.I.T. audience last fall.

panel kept lawyers from both sides on hand for all their tests, "to show them that research can be a very messy thing," Dr. Bolt said.

Caterpillar Tractor Tracks

To make visible the magnetic fluctuations made by the tape recorder head, the team poured a fluid containing magnetic particles on the evidence tape. The particles collected on the magnetic pattern in proportion to each pattern's magnetic strength, resulting in lines along the tape that Dr. Bolt said looked "much like the track of a caterpillar tractor."

The fluctuations of these lines along the length of the tape gave some information; but especially useful was measuring their width across the tape. Each make of tape recorder has recording and erase heads of a unique width, making it possible to identify a given make of tape recorder by measuring the width of the magnetic patterns left by one or both of its heads.

The group discovered that Rosemary Woods' Uher 5000 matched the erase marks on the buzz section of the tape, with an erase mark 3.0 millimeters wide, and a record mark of 2.4 mm. wide. (Both erase and record heads are in operation when a tape recorder erases.)

Another clue was the distance between the two marks: 28.6 mm., precisely the distance between the two heads of the Uher 5000. Still another clue: each tape recorder records sound waves at slightly different positions on the tape, some closer to the edge, some farther. The erase marks made by Miss Woods' recorder were the same distance from the edge as the mysterious erasures in the gap. On the other hand, the other White House Uher recorder, belonging to the Secret Service, recorded magnetic signals at a distance of 0.2 mm. offset from the erasure marks.

Simple measurement was not enough to decipher the other strange sounds on the tape. The panel produced other signatures from the tape by playing the tape onto an oscilliscope screen and using a digital computer to zoom in on the details of the complex pulses.

Spectrographs of the sounds on the tape were also useful. Whether voice or buzz, every sound is made up of component signals at various pitches or frequencies. By breaking a sound down into the original frequencies, it can be characterized. The panel went over the buzz section, analyzing how the component amplitudes and frequencies changed with time along its length. Tiny "windows" of voice, which had not been erased, were found: proof that the buzz had actually been taped over voices, and was not a part of the original recording.

Off Again, On Again

Each tape recorder has a distinctive flutter (the slight eccentricities of motion due to irregularities in the rotating spindles which drive the tape) and the White House machines were no different. The flutter found on the buzz was distinctively that of the Uher 5000 used to transcribe the president's tapes.

The investigators capped their report by determining how many stops and starts had occurred in those 18.5 minutes. "At least five and not more than nine," they reported, and rested their conclusion in part on the number of times the speed of the tape varied. Since it takes a moment for a tape recorder to reach its average speed immediately after it is switched on, the panel was able to visualize the "turn-on" event in the wave patterns derived from the three tests.

Allowing for human factors in their experimental reconstruction of events, the panel found that it takes a person from 0.3 to 0.6 seconds between hearing the end of a sound on tape and punching a button on the recorder. "We all tried it, and then took an average of our response times," Dr. Bolt said. This helped explain two events on the tape, gaps of 0.3 and 0.55 seconds.

The machine itself takes a smaller fraction of a second to coast to a stop after the power is turned off, and events matching this were also found.

These and similar studies using computers were conducted independently by panel members at Bell Labs in New Jersey, in Dr. Stockham's University of Utah office, and at Bolt Beranek and Newman, Inc., in Cambridge, Mass., Dr. Stockham revealed. The results agreed, and assured the veracity of the panel's report to the court of January 15, 1974. As further precaution, the panel met for a six-day "poke holes in the findings" session before testifying, and still remained in agreement as to the actions they had inferred from the sounds on tape.

The final report, issued May 31, 1974, is clear in its accusation of the Uher 5000 tape recorder. But public speculation on the identity of the manipulator of the tape recorder found on Miss Woods' desk remains beyond the panel's ken. Said Dr. Bolt, "We always said that the tape *was* repositioned, *was* erased, or *was* moved. We were very careful to use the passive voice."

Trend of Affairs

Trends This Month

MEDICAL TECHNOLOGY

Artificial Skin and Arteries

A new material made from carbohydrates reinforced with the protein collagen shows promise as an artificial skin for burn victims and for surgical implantation as artificial blood vessels.

Tests on animals suggest that three important problems may be solved — rejection as a foreign substance, premature degradation by body enzymes, and interactions with blood constituents. As a result, Ioannis V. Yannas, Associate Professor of Mechanical Engineering at M.I.T., is optimistic that the new carbohydrate-collagen films will have significant surgical value. But he stresses that more tests are required before any use with human patients can be contemplated.

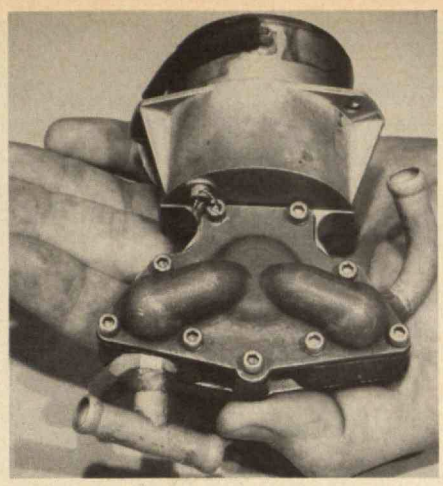
The approach of Dr. Yannas and his colleagues has been to create substitutes for blood vessels and other connective tissue, such as skin, in the same way engineers for two decades designed fiber-reinforced composite materials: carbohydrates known as mucopolysaccharides (MPS) have been reinforced with collagen fibers.

Collagen alone can be formed into films, but blood platelets react with collagen to initiate the formation of blood clots. Dr. Yannas and his colleagues reasoned that MPS might mask the collagen, eliminating reactions between film and platelets. It seems to work; hence the new film's promise for artificial blood vessels.

The composition and structure of the carbohydrate-collagen film affects the rate at which the new material is broken down by body enzymes. That rate is a crucial issue in creating an artificial skin for grafting; premature degradation transforms a graft into useless fluid too soon, but inadequate degradation prevents living tissue from entering the graft and synthesizing new material. Hence the use of carbohydrate-collagen film for skin grafts.

Testing continues under the auspices of the Biomaterials Science Program of the Harvard-M.I.T. Program in Health Sciences and Technology, supported by the National Heart and Lung Institute. — *J.M.*

Magnified 1,000 times, synthetic skin designed in the M.I.T. Department of Mechanical Engineering (left) from carbohydrates with collagen fibers implanted closely resembles guinea pig skin (right). The new material is now being tested at Beth Israel Hospital and Shriners Burns Institute, Boston, for possible use for skin grafts and blood vessel replacements.



The "Apollo Double-Diaphragm Pump," which circulated coolant throughout astroanuts' suits on the moon, has also proved to be a very gentle blood pump. (Photo: N.A.S.A.)

Another Surprise from Apollo

When Neil Armstrong took his first tentative steps onto the surface of the moon, he carried as part of his life-support backpack a small, efficient pump to circulate temperature-regulating water throughout his space suit.

Now, very much to his surprise, he and his colleagues on a bioengineering team have discovered that the same device makes a superior blood pump, ten or more times less damaging to red blood cells than previous pumps.

Neil Armstrong, Professor of Aerospace Engineering at the University of Cincinnati, now ponders various problems in bioengineering with three other prominent scientists, Henry J. Heimlich, George Rieveschl, and Edward A. Patrick. The four, with a love of acronym reminiscent of the Apollo program's heyday, dubbed their team H.A.R.P., after the first letters in each scientist's last name.

The decision to try out the "Apollo Double-Diaphragm Pump" as a blood pump to be used in heart-lung machines and artificial hearts and kidneys was made principally because of the pump's reliability, small size, high-output, and efficiency. It was quite unexpected that the pump would also be exceedingly kind to blood cells, said H.A.R.P. in a paper at the annual meeting of the Association for the Advancement of Medical Instrumentation held in Boston.

The scientists borrowed the pump from N.A.S.A, and with no preparation ran anticoagulant-treated canine blood through it and measured its hemolytic index — the amount of hemoglobin released from disrupted blood cells as a result of passage through the pump. They found the hemolytic index to be far better than other pumps reported, even without special plastic and other linings to reduce blood damage, as were used in other pumps.

The Apollo pump consists of two chambers, each with its own inlet and outlet valves. Between the chambers is a rocking arm connected to a diaphragm in each chamber. As the arm rocks back and forth, propelled by a highly-efficient electronic solenoid motor, it simultaneously pressurizes one chamber and depressurizes the other, emptying the former and filling the latter. The output vent of the pump combines the two alternately pulsing chambers, resulting in a smooth flow.

Blood is an incredibly delicate substance, subject to severe damage from prolonged mechanical pumping. Among the problems: hemolysis, "ghosts" (envelopes left over after blood cells disrupt), anemia, increased viscosity, and protein denaturation. These problems are caused by surface contact of cells with the pump surface and shearing of cells across the surface of the pump.

Although the benign behavior of the pump was unexpected, the H.A.R.P. team had some preliminary theories about the device's success. For use in Apollo space suits, the pump had to be highly energy efficient, and thus could create very little turbulence in the fluid flow; as a result, blood flow through the pump would be smooth. The pump, to be reliable, is designed with no moving parts in the flow to damage blood, and the highly efficient check valves also minimize flow disruption.

The H.A.R.P. team stressed that the device they used was just off the shelf from N.A.S.A., and that further engineering and improved linings should make for even better results. — *D.M.*

Magnetic Medicine

Chad Stephens of South Attleboro, Mass., now eats like any other 18-month-old boy. But until three months after birth he had swallowed no food, because he was born with a congenital defect — an incompletely formed esophagus.

Perhaps one in every 2,500 infants displays such a deformity. A major operation is typically required to rebuild the malformed tissue into a functional esophagus. In 20 per cent of the cases the tissue is so inadequate that surgeons must construct and install a section of artificial esophagus from a piece of intestine.

Chad Stephens faced such an operation, but he was treated instead by a new method which involved implanting small metallic "bullets" in each end of his incomplete esophagus, initially several centimeters apart. Chad was then placed in an intermittant electromagnetic field — on for 60 seconds, off for 90 seconds — arranged so that the "bullets" were pulled toward each other, stretching the two ends of the esophagus some 600 times every 24 hours. After a little less than two months, the two ends were close enough together so that surgeons could safely join them, removing the "bullets."

The magnetic treatment was reported during the fall in the *New England Journal of Medicine* by Dr. W. Hardy Hendren, Chief of Pediatric Surgery at Massachusetts General Hospital, and J. Richard Hale, Staff Scientist at the Francis Bitter National Magnet Laboratory at M.I.T. They are optimistic about future esophageal operations — and also about applications of the system to other defects, such as a so-called "imperforate" anus. — *J.M.*

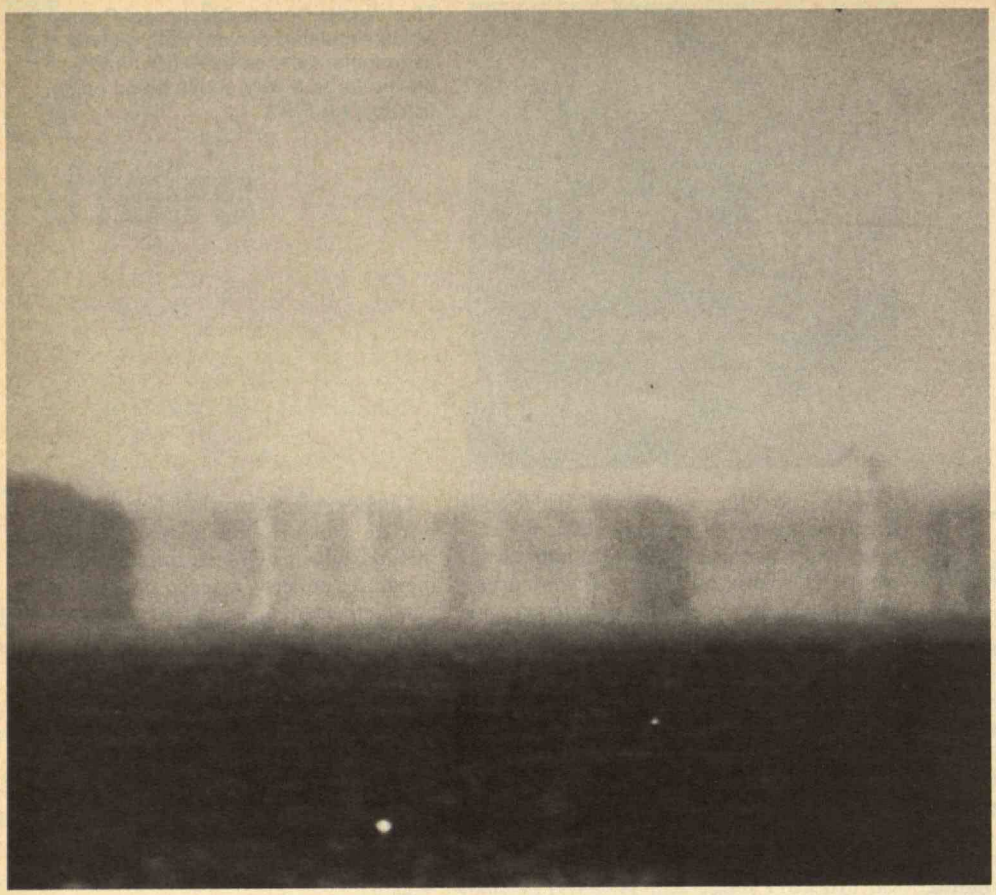
MYTHS AND MIRAGES

Wake of the Flood

Over the years anthropologists have accumulated hundreds of myths from all over the world, relating how floods instantly wiped out entire civilizations. The most popular explanation for this particular myth's ubiquity is that primitive people need a culture hero who can survive catastrophe and regenerate his clan.

Cesare Emiliani of the University of Miami has another explanation: a flood.

About 11,600 years ago (the same time Plato cites for the submergence of Atlantis), the thin Laurentide ice sheet covering most of North America suddenly surged southward, only to melt as quickly as it advanced, Dr. Emiliani claims. This caused flooding of low lying areas, both inland and coastal, "many of which were inhabited by man, giving rise to the deluge stories common to many traditions," according to Dr. Emiliani in *Science*



In the hazy distance, open ocean appears studded with blocks and pillars. Centuries ago this was deemed the work of Morgan le Fey, and the mirage still bears her name — fata morgana. (Photo courtesy of Penn State.)

magazine (September 6, 1975).

He and his seven colleagues base their assumptions on analysis of two sedimentary cores taken from undersea areas off the northwest coast of Florida. These core samples are significant in that they were affected by both the Mississippi and gulf currents, and are examples of undisturbed layers of sedimentation, the group says.

Radiocarbon dating of the microscopic fossils in the cores, analysis of the oxygen isotopes of those same fossils, and studies of the types and species of the fossilized shells all yielded correlative data: around 9600 B.C. the water in the gulf of Mexico was colder by 3°C. and less salty. In paleological terms, these conditions were only momentary. The data indicate to Dr. Emiliani that a sudden melt of snow most likely cooled and freshened the water, and slightly raised the sea level.

John Edmond of M.I.T.'s Department of Earth and Planetary Sciences has his doubts about the evidence gathered from the cores. He thinks that cores taken from such shallow water will not present a true picture of events so long ago. Nor does the theory of the final surge of the Laurentide ice sheet convince him: "A surge happens over years. That it would cause such flooding all at once does not coincide with what we know of glaciers now 'surging' in Antartica.

"All you can say is that it is not very likely," Dr. Edmond concluded. "But it's a great story." — *S.J.N.*

Castles in the Air

"The ocean rose up and looked like a dark mountain range," wrote one Italian monk in the seventeenth century. "There quickly appeared a series of over 10,000 pillars" which shrank and reformed to "arches like those of the Roman aqueducts." He went on to describe castles, forests, and buildings with tall towers and windows, all drifting over an open ocean.

This sight, which often greets mariners sailing the strait between Sicily and the Italian mainland, comes not from religious fervor, but from a singular combination of temperature and atmospheric density known as the fata morgana, says Alistair B. Fraser, meteorologist at the Pennsylvania State University.

The fata morgana is a complex type of mirage, named after Morgan le Fay, half-sister to King Arthur and a powerful, evil sorceress. But the Italians thought of her as a water fairy, and attributed to her the strange visions (such as our poor monk's) that haunt the Strait of Messina.

"Mirages are caused when the atmosphere acts like a magnifying glass," Dr. Fraser told the Optical Society of America last fall in Boston. The fata morgana itself occurs most often over enclosed bodies of water, such as straits or large lakes, where air warmed by contact with the land flows over cooler air rising off the water; arctic snows also breed the fata morgana, when the air in immediate contact with the snow surface stays cooler than higher, radiation-warmed air. Commander Robert Peary fell victim to Fata Morgana's tricks when in 1906 he discovered Crocker Land, a range of mountains deep within the Arctic Circle. Not until 1913, when explorers returned to chart those mountains, was the truth discovered.

Over ice and water alike, explains Dr. Fraser, the temperature gradient transforms the atmosphere into a lens. Add astigmatism, horizontal and vertical curvatures of the temperature gradient, and a certain amount of blurring, and amazing optical illusions are created.

The kaleidoscopic changes in the monk's vision are easily explained by these events, according to Dr. Fraser. For example, the aqueducts result from a vertical oscillation between strong and gentle temperature differentials. Because the "lens" creating the mirage is heir to the vagaries of wind and wave, the illusion can change shape without warning. "The total brightness is not changed, only redistributed," says Dr. Fraser.

It has long been known that inversion of normal temperature patterns, and thus of normal atmospheric density distribution, causes the bending of light rays we see as mirages. Dr. Fraser is the first to predict the occurrence and behavior of so complex a mirage as the fata morgana. — *S.J.N.*

Nuclear Power and Violence

The dangerous era of international nuclear power is already here. The question now is how to control acts of nuclear violence in a world filled with nuclear machines.

To that worrisome question there is yet no answer. Six experts who spoke to a seminar of the M.I.T. Club of Washington, D.C., late in the fall admitted their uneasiness: materials necessary to any large-scale use of fission-made electricity can be turned into explosives with only modest expertise; nuclear power could easily prelude nuclear blackmail — or nuclear holocaust.

Three degrees of tragedy can be hypothesized. Minority dissidents and terrorists — a near-lunatic fringe — could use home-made bombs in extortion. Or legitimate if unscrupulous political minorities could attain domestic power using clandestine explosives. Or, most fearful to Mason Woolrich, co-author with Theodore B. Taylor of *Nuclear Theft: Risks and Safeguards* (Ballinger Publishing Co., 1974), nations could use peaceful fission systems as sources of nuclear armaments for pressing selfish national purposes.

The six panelists — all advocates of nuclear power — agreed that, at least so far, no systems can be conceived to promise absolute security in a fission-powered age. But they have fair confidence in careful inspection and accounting on a national level, aided and enforced by the International Atomic Energy Agency — especially if the nuclear economy linked heterogeneous nations so that rivals became interdependent.

Two incentives to security are built into such a system: the maximum return on investment in nuclear power is very consistent with good safeguards; and all governments have in common the need to maintain security from terrorists and political minorities. If the U.S. can demonstrate how to maintain nuclear security by "putting its own house in order," said Dr. Woolrich, every well-intentioned nation will welcome our leadership and follow it.

But what of the ill-intentioned nation, determined to extend its international power with nuclear weapons? It can easily enough hide its plans and progress from the international community. But that nation deludes itself — and so do the rest of us, said Dr. Taylor. Nations — "haves" and "have-nots" alike — still behave as if nuclear armaments were a source of security. But this is not at all the case: one nation's use of a nuclear explosive will bring disaster to all nations, including the aggressor. We need the courage to renounce nuclear weapons, accepting the truth that we are in fact more secure without them, said Dr. Taylor.

Two questions from the floor for Congressman Mike McCormack, presiding at the seminar:

— Does the U.S. have the political courage to begin such a chain reaction of nuclear disarmament? "That's the toughest problem this society or any other has had to face up to," said Mr. McCormack. Such disarmament is the ultimate goal of S.A.L.T.; but for now his answer is in the negative. And he admits that to an underdeveloped nation, an outsider in the nuclear club, that answer is "an act of ultimate hypocraisy."

— Is the power from the atom worth the risk to the world? It is, said Congressman McCormack. "Turning away from nuclear power would be a greater sacrifice than any risk we can conceive in the nuclear age." This is because "responsible leaders have the task of preserving both the viability and the prosperity of their societies." — *J.M.*

The Energy Balloon: Squeeze Here, Out There

At first glance — which is how most of us look at it — energy conservation is simple: buy storm windows and save heating oil; or take the bus and save gasoline. A deeper analysis reveals that conservation is not at all so uncomplicated: what about the energy required to make your storm windows? What of the automobile mechanic whose services you need less often? And what will you do with the money you will save on fuel oil, thanks to the storm windows?

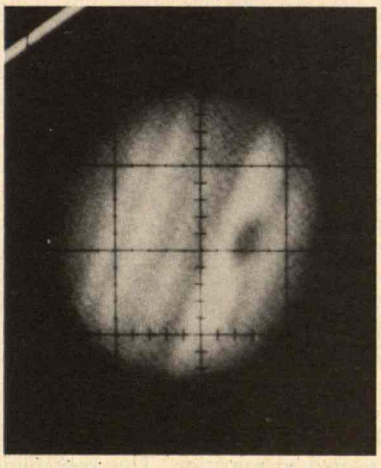
It was an analysis of energy conservation at these interrelated levels that brought Professor Bruce M. Hannon of the University of Illinois the Mitchell Prize at the 1975 Limits to Growth Conference *(see Technology Review January, page 19)*. In his winning paper Professor Hannon identified three dilemmas of energy conservation:

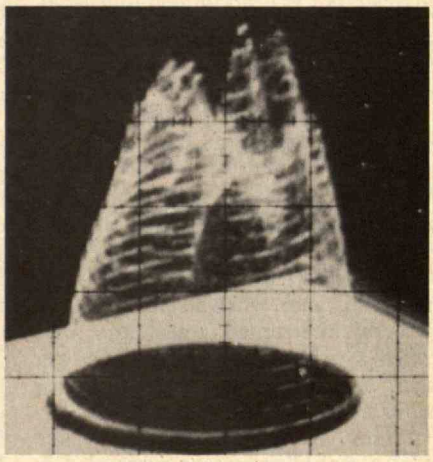
— Our traditional approach to prosperity has been to achieve high productivity of labor and capital by applying increasing amounts of low-cost energy. If the price of energy goes up, the leverage on productivity is reduced, and pressure to conserve energy is likely to look like pressure to reduce the productivity of labor and capital by applying increasing amounts of low-cost energy. If the price of energy goes up, the leverage on productivity is reduced, and pressure to conserve energy is likely to look like pressure to reduce the productivity of labor and capital.

— Energy demand is closely related to income level and thus to life style. We all resist changes that mean more work, less convenience, and perhaps less comfort in day-to-day life, but these are precisely the changes that will result from true energy conservation.

Light in 3 Dimensions

The two-dimensional photograph of Jupiter (*left*) is converted at the right into a three-dimensional display in which the height of the image corresponds to the intensity of the light at the corresponding point of the two-dimensional picture. The three-dimensional image is created by a solid-state scan-converter designed and built by Michael Brookes of the M.I.T. Department of Earth and Planetary Science with funds from the National Science Foundation; the device has also been used at the Mt. Wilson Observatory and it's being copied for the Cerro Tololo Inter-American Observatory in Chile.





— Total energy consumption is closely related to total national income. A consumer who saves energy will have money, representing the cost of the saved energy, to spend on something else — travel, a new air conditioner, or a new car — or to put in his savings bank. The alternatives — including even the savings bank — may represent as much energy consumption as the consumer originally saved by installing storm windows or closing his weekend home for the winter.

"The real meaning of permanent energy scarcity," said Dr. Hannon, "is that everyone will have to work longer and probably harder to use less energy while also preserving income." — *J.M.*

Spinning an Electric Web

The complex national electric power grid, with its labyrinth of interconnections, generators, and relays, is frequently a seat-of-the-pants operation. Built by engineers, the grid is run by technicians who, without engineering knowledge, learn to "feel" how to manage the electric imputs and demands of the system.

Because of the dangers of experimental interference with the grid system, neither the engineers nor the technicians can "play" with the grid except on an extremely limited basis — experimenting late at night when demand is lower, or making only non-interfering measurements.

A miniature electric power system, complete with scaled-down generators, transformers, control mechanisms, circuit breakers, and transmission lines has been built at M.I.T.'s Electric Power Systems Engineering Laboratory, at present the only real-life system available to allow free study of the ebb and flow of electricity in a grid.

The model, built by Stephen D. Umans under the direction of Gerald L. Wilson, Director of the Laboratory, is one-millionth the size, electrically, of an actual power grid. Two 900-watt generators and one 600-watt generator mimic the behavior of real generators one million times larger. Similarly, miniature high-voltage wires simulate a total of 400 miles of such lines, and rows of electrical light bulbs represent a scaled-down version of the electricity requirements of a small community.

Although mathematical models of power systems can offer some insight, such computer models, no matter how sophisticated, do not behave like real systems. For instance, when an electrical load is suddenly interrupted, a generator loses electrical synchronization with the power system, and oscillates as the generator controls alternately overreact and underreact. This "transient" behavior — like that of a wobbling weight suspended in the middle of a taut rubber band — is eventually damped, but mathematical equations used in simulating power systems do not accurately predict such damping. The M.I.T. model, in fact, is being used to improve computer modelling of this behavior.

The system is now being used to test controls and other electrical devices in a real-life situation — a much more useful approach than "constructing" the devices mathematically. The system will also be used to develop control strategies for power systems, significant since power grids now operate with little reserve capacity because of the heavier demand and fewer generators imposed by the present energy shortage.

Finally, the engineers hope to use the system to give engineers and power system operators a chance to "play" with a real system to see how it behaves in emergencies or other situations. Such knowledge could mean the difference between losing a power system and keeping it going. During the famous 1965 blackout in which practically all of the northeastern U.S. lost power, two small areas — Holyoke and Braintree, Mass. — kept their electricity flowing. They survived the blackout because the experienced operators of those two systems did precisely what they had been trained never to do. Seeing the power system going down around them as it strained to maintain itself under a heavier and heavier load, the operators tripped relays isolating their power systems and saved their communities from going down with the electrical ship. — *D.M.*

WOMEN

Fat and Fertility

Overpopulation is not as naturally inevitable as the Reverend Malthus once claimed: recent evidence suggests that the ability to conceive is turned off as a part of the body's response to starvation and undernutrition. According to Rose E. Frisch of Harvard University's Center for Population Studies, a woman does not conceive when her body lacks enough energy, stored as fat, to support her child and herself through nine months of pregnancy and a few months of breast feeding.

This discovery resolves some puzzling historical anomalies. For example, the poor of England and Scotland in the nineteenth century had only six or seven children, compared to the maximum possible of 11 or 12. Until recently, historians have assumed these people limited their families through folk methods of birth control. The alternative explanations (lowered fecundity through later onset of menses, earlier menopause, long periods of nursing without return of cycle, and higher miscarriage and stillbirth) can all be related to nutrition. This reexamination of history is of more than academic interest, for the same family pattern is being repeated in India and in other developing countries today.

Poor women of today, like their nineteenth-century sisters, have fewer children than do well-nourished women who don't practice contraception. The reason: malnutrition may reduce fertility. Nursing women burn 1,000 extra calories a day. In the United States, this heavy caloric demand is on the whole easily met, so a nursing woman needn't consume her body's reserves to support her children. A poorer woman, whose daily caloric intake often falls short of her own needs, is unable to regain needed fat until she stops nursing, and thus may not resume normal menstrual cycles until 16 to 18 months after giving birth; American women usually resume within three months.

Dr. Frisch refers to articles in nineteenth-century British medical journals on the relationship of nutrition, reproduction, and body weight. "This concept of reproduction as an energy requiring process, and of nutrition as affecting fertility, was known then, and even holds true for animals from chickens to elephants," according to Dr. Frisch. "The records of the time show that naturalists and doctors were aware of this, but the idea was temporarily lost when the emphasis of reproductive biology shifted to endocrinology."

Her discovery of the close relationship between body composition and reproductive ability came about by accident. To relieve the monotony of collecting weight data on the ages at which girls reach puberty for a food supply study, she began to collect and correlate height and weight data in relation to calorie supplies. Her findings led her to pursue a detailed study over a five-year period which showed that the onset of menarche was best explained by growth data. "This relationship explains why today's typical American girl attains menarche at about 12.6 years instead of at 14.6 to 15 years, as she did a hundred years ago," Dr. Frisch adds.

Reporters have pressed Dr. Frisch for her version of the "contraceptive diet," but she demurs: the body's reaction to 10 to 15 per cent loss of body weight is one that saves the malnourished woman from being starved to death by a newly conceived child; it's certainly not a method of contraception.

She expresses concern that her findings on the fat-fertility relationship might be used as "scientific" documentation of the negative value of sending surplus food to the underfed populations of the world. She emphasizes that her findings suggest more that poor people in developing countries do *not* practice folk (or any) methods of contraception, as had been previously thought. She believes "a greater effort is needed to provide contraceptive methods together with adequate nutrition." — *S.J.N.*

FOOD

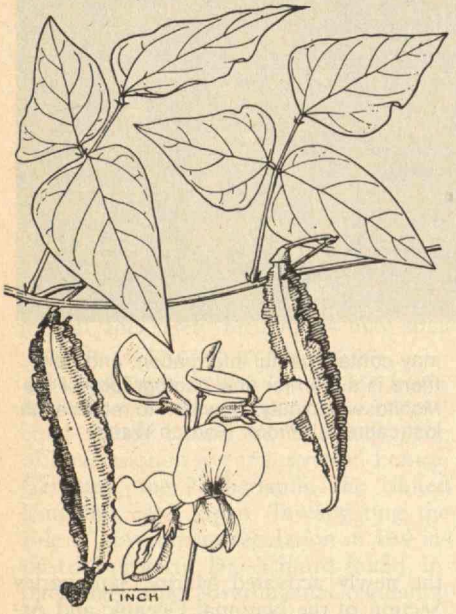
Milk at Room Temperature

Supermarket customers of the 1980s may find the fresh milk with the canned peas, rather than in the dairy cooler: a North Carolina scientist has developed a process whereby fresh milk is sterilized at ultra-high temperatures (a sort of pasteurization plus) without ruining the taste.

Dr. Harold E. Swaisgood and his coworkers at North Carolina State University at Raleigh have isolated an enzyme that restores the flavor to fresh milk which has been heated to temperatures that kill all bacteria. The enzyme, sulfhydryl oxidase, converts the chemical group disulfide into sulfhydryl, the reverse of the taste-destroying reaction.

The enzyme, developed as part of the National Science Foundation's R.A.N.N. program, could produce huge energy savings for processor, distributor, and customer alike, Dr. Swaisgood believes, because milk would no longer need refrigeration. Only after the sealed container is open, he says, is refrigeration required.

So far, the enzyme has been successfully bonded to glass beads so it can be recovered after sterilized milk is passed over it. Dr. Swaisgood and his colleagues are now working on extending the life of the enzyme. — *D.M.*



New Crop for the Tropics

An update on the ongoing green revolution: one small skirmish may have been won in the back yards of Papua, New Guinea.

The winged bean is grown there.

This obscure plant, now grown only in small household gardens, has the potential to ease malnutrition in the protein-starved tropics, according to a recently released report by the National Science Foundation.

Enumeration of its advantages makes one wonder why the winged bean hadn't been discovered long ago. The beans average 34 per cent protein, taste much like green beans when raw, and like soybeans when dried, but without the sharp "beany" flavor so objectionable in soybeans. The roots, stems, flowers, and leaves can also be eaten. The roots, in fact, could be a high protein substitute for potatoes, yams, or other tubers. The researchers found that the use of the plant varied from place to place, but nowhere was full use made of the winged bean.

The bean is responsive to continuous harvesting, advantageous to the small truck farmer, and can be grown at high or low altitudes in wet or dry (with irrigation) tropical climates. Like other legume crops, the winged bean fixes nitrogen from the air and so can grow in poor soil without fertilizer.

All this is "unusual" for a tropical plant, said the report, and a major development effort, similar to that made on the soybean, is recommended for this "exceptional legume." — *S.J.N.*

METALS

A New Technology of Metals as "Mush"

"A radical and technologically important innovation in metalworking" — a technique for casting metals and alloys hardened to the consistency of melting ice cream, thus resolving two major problems in casting molten metal — has been developed in the Department of Materials Science and Engineering at M.I.T.

The central process has been named "rheocasting," referring to the greater variability in temperature allowed by the process. The innovation involves the use of agitated metal alloys, halfway between liquid and solid. The metal is cast as a liquid-solid mixture with the consistency of soft ice cream, and it flows into the mold "like a liquid slurry," write the inventors of the process, Professors Merton C. Flemings and Robert Mehrabian.

The process outshines conventional casting for two reasons: the metal is cast at a lower temperature, contains significantly less heat, and causes far less thermal shock to the mold, making for significantly longer die life and greater range of materials (materials of higher melting points can be used); and castings are of more uniform quality because the semi-solid metal undergoes less shrinkage and entraps less air by splashing less in pouring.

When the slurry metal is held at its less-than-liquid temperature, it gradually hardens into a "gel" which can be treated as a solid. Cooled and later reheated to this temperature, it retains its solid characteristics until sheared, when it flows as a liquid. Hence the processes Professors Flemings and Mehrabian call "thixocasting" or "thixoforging": casting machines can be fed their raw material in "solid" form, and forging machines require only low die pressures to form the material.

Another by-product process is "compocasting": solid particles or fibers mixed into "rheocast" slurries do not agglomerate or float out as they do in fully liquefied materials, making possible casting of composites.

In future work Professors Flemings and Mehrabian hope to develop a process of "rheorefining," in which solids and liquids in the semi-solid alloy are separated to purify both liquid and solid materials; the result, they think, will be a process for removing impurities which cannot be readily removed by conventional refining. — *J.M.*

Urban Minerals

Ore-bearing formations trend across national boundaries, which are political, not geological. Yet of 20 metal mines along the border between the U.S. and Canada east of the Great Lakes, 16 are in Canada, four in the U.S. — a result, says J. R. Dunn, Chairman of Dunn Geoscience Corp., of "cultural nullification."

Some "cultural nullification" — human activities which render valuable mineral concentrations unavailable or uneconomic — occurs in the eastern U.S. simply because land otherwise valuable for minerals has been turned to urban use. There were, for example, 68 fewer sand and gravel quarries in the greater New York metropolitan area in 1970 than in 1964.

But Mr. Dunn's real target is different: he is disturbed about political land use decisions which foreclose valuable minerals resources to mining. "A case can be made for the statement that we may not *run* out of resources; we may *think* ourselves out of them," he told the 1975 convention of the American Mining Congress.

To ease the problem, Mr. Dunn proposed a federal mining compensation system: let the Internal Revenue Service pay to each region of the country an annual bonus which is a small percentage of the gross value of mineral production on which depletion allowances have been calculated for that region — including oil offshore of the region — up to a limit of perhaps $500 per person. Let the money be devoted to projects "which have high visibility," said Mr. Dunn — he suggested schools and recreational facilities — so that the process will be effective in encouraging states and communities to allow mineral production. He thinks the

system would open new land to miners, restore healthier competition to the mineral industry, and stabilize (and perhaps reduce) mineral prices. — *J.M.*

The How and Where of Wear

Machinery and aircraft had been around long enough by the 1930s to demonstrate that the wearing of metal surfaces is indeed a problem.

But it appears that the explanations for wear offered by metallurgists for the last 35 years have been wrong — so wrong that when Nam P. Suh, Professor of Mechanical Engineering at M.I.T., found the real cause of wear, he had to invent his own word to explain it.

Until recently the "adhesion theory" of wear has been accepted. Once over lightly, the adhesion theory holds that wear occurs when hunks of metal, called asperities, are dislodged from the uneven surface of the metal and caught in the juncture of the moving surfaces. These plow against the smoothed metal, wearing more discontinuities in the surface.

Not so, says Professor Suh. Asperities are so tiny and soft that they are smeared between the surfaces in the first few rubs, and couldn't possibly be the cause of damaging wear.

Professor Suh offers the "delamination" theory of wear. Delamination is a word coined by him to account for microscopic sheets of metal which are dislodged when two surfaces rub together, "delaminating" those surfaces in progressively deeper layers.

What happens, he claims, is that discontinuities such as tiny cracks, air bubbles, and the like pile up and tangle beneath the surface. Since the pressure of immediate contact has caused the surface of the metal to "work harden," the discontinuities are trapped at a predictable level under the metal's surface. When the pile-up becomes uniform over a large enough area, a sheet of metal is loosened and falls off.

Because the depth of the crack which causes the unlayering is predictable, Professor Suh has found a cure for wear. He suggests a softer coating, thinner than its own characteristic crack depth and thicker than the base metal's characteristic crack depth, over the surface of the metal. The theory predicts that cracks will grow in neither the base metal or the soft surface. Professor Suh's success in preventing wear is not total, but his layering method has been tested at 500 times less wearing than a comparable uncoated surface. — *S.J.N.*

An Eye for the Camera

Remember that underwater camera abandoned in the wreckage of the *Monitor,* described by Harold E. Edgerton, Institute Professor, Emeritus, at M.I.T., in the February issue of this journal *(see "The Monitor Is Found," pp. 8-9)*? A proposal is now complete for further photography to reveal new details of the *Monitor* wreck and — perhaps — to show how to retrieve the lost camera.

Why the additional photographs which are now proposed by Professor Edgerton and John Newton, Marine Superintendent of the Oceanographic Program at Duke University's Marine Laboratory, Beaufort, N.C.? Because the earlier photographs are all vertical and from above the wreck. The new pictures now being planned are to be horizontal ones, from the side. These side-view pictures should reveal additional information. One question that may be answered: "Are the cannon ports on the turret aimed outward?" If outward, perhaps photos can be made through the ports to see if the two 11-inch cannons are still there.

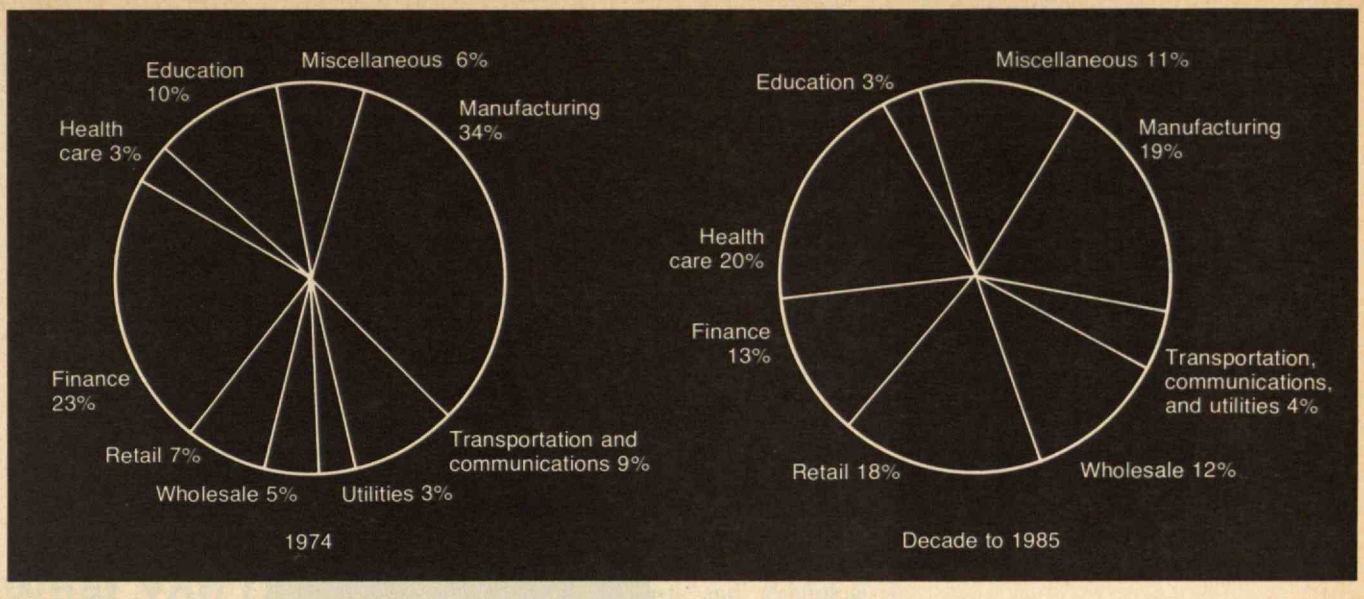
Numerous other underwater photographs will be of value to archaeologists and others who are to study the wreck in the future.

After eight months in the *Monitor* wreck, Professor Harold E. Edgerton's underwater camera (the rectangular frame at the lower right) is covered with sediment and corrosion. But the film in it is still good and may contain useful information, and now there is a plan for new photography of the Monitor which may show how to retrieve the lost camera. (*Photo: Gordon Watts*)

A horizontal-looking camera with strobe light, hung by a wire from a surface ship, will require several basic support items. First, the ship must be positioned so that the camera will arrive at the correct place when lowered into the current. Second, the camera must be pointed (rotated) so that the lens is directed at the subject. Third, the exposure must be arranged to occur at the instant when the camera is properly aimed at the subject. All of these requirements need to be fulfilled by skillful manipulation by the surface operator.

The new camera-strobe will be mounted on a framework which can be rotated by electrically actuated jets of water. A television camera near the photographic camera will serve as a remote viewfinder. Nearby is a push-button which controls the photo instant.

Drs. Edgerton and Newton have submitted a proposal based on this plan to the newly activated Marine Sanctuaries Section of the National Oceanic and Atmospheric Administration (N.O.A.A.) which has control of the *Monitor* site off Cape Hatteras. Meanwhile, the National Geographic Society's Research Committee has made funds available for the new camera-TV equipment which is now undergoing tests in the M.I.T. swimming pool, the Charles River, and Boston Harbor. — *J.M.*



The largest buyers of electronic data processing in 1974 were manufacturing and financial institutions. But tomorrow's computer salesmen will find their best customers in the health care, retailing, and wholesaling businesses, according to a survey of future computer markets by International Data Corp.

A Helpful Nudge for Sleepy Industries

The scenario is a familiar one: Industry X is found to be a polluter or to pose a special health hazard to its workers. The government imposes environmental or health standards, bringing an immediate charge from Industry X that plants will be forced to close; prices will rise; people will be thrown out of work; the industry endangered; *the economy — threatened!*

Not necessarily so, according to Nicholas A. Ashford of M.I.T.'s Center for Policy Alternatives. Far from endangering technological innovation — the basis for industrial growth — environmental and safety regulations may spur industry on to even greater success.

In testimony before the Senate Commerce Committee in June, Dr. Ashford cited a study he and his colleagues made of innovation in five industries in France, Germany, the Netherlands, the United Kingdom, and Japan. Investigating the role of government regulation in 164 industrial projects, Dr. Ashford found, interestingly, that governmental regulation was more likely to be found in association with the successful projects. This was especially surprising in view of the fact that government policies aimed directly at spurring innovation showed no relation to the projects.

From the engineer's viewpoint, Dr. Ashford reasoned, environmental/health standards were just one more set of constraints added to his design problem for a new product or process. But, said Dr. Ashford, these constraints were not all that restraining, because there was usually a reservoir of untapped technology in the field — and all the engineer had to do was turn the tap. Also, since government regulations were usually quite precise, they were easily plugged into the design of a new machine or process.

Initially, there may have been higher costs, slowdowns, roadblocks, and uncertainties which hindered some industries after new pollution or safety regulations were imposed. But the encouragement of technological innovation by new regulations seemed to be more important.

"We see that firms — especially large firms and older firms — become caught in an inertial circle which hampers their innovative potential, and from which governmental regulation may extricate them," said Dr. Ashford.

What's more, he said, governmental regulation has created an enormous new growth industry in creating a demand for pollution control and safety equipment. "This industry has experienced a period of incredible growth and prosperity during the last five years, suggesting the conclusion that whatever flagging profits may result from environmental constraints elsewhere are being absorbed by the pollution control sector.

"One sees, therefore, that regulatory costs, far from being a net drain on society, actually are a transference of wealth from one sector to another." — *D.M.*

The Changing Computer Market

In three decades computers have changed the way almost every American lives and does business. But there still remains in the U.S. a very large spending potential for electronic data processing.

Hospitals are the biggest single future market, says a survey by International Data Corp. The most sophisticated of today's hospitals use electronic data processing at the rate of $7 per patient day. To equip every hospital in the U.S. to work at this level would cost almost $2.7 billion; though that figure exaggerates the market (small hospitals may never justify such extensive electronic data processing), health care remains the most important single target for computer salesmen in the next decade.

Banks will be the number two customers. Despite the substantial investments in electronic data processing by commercial and savings banks in the past — 22.5 per cent of 1974 spending on computers was by financial institutions — there remains a market potential of over $925 million.

Next in line is the food industry, with an $850 million potential including both retail and wholesale users.

For at least another decade, electronic data processing will be an industry with changing markets. The four largest future markets — health care, finance, retail, and wholesale — accounted for only 37 per cent of 1974 spending on electronic data processing. Together they have 63 per cent of the future potential. — *J.M.*

The more American energy we can get for American cities,

the better off our country will be.

For three out of every four Americans, home is the city. Our great metropolitan areas are the centers of commerce, industry and culture.

They must have a sufficient, dependable supply of energy.

But our domestic energy supply has been allowed to deteriorate. And our dependence on foreign oil has tripled since 1960.

Amoco believes America must greatly intensify the development of American energy resources.

We and other members of the energy industries have the know-how and the manpower to do the job, but we need national policies that allow energy producers to be able to make long-range commitments.

Finding new energy won't be easy, and it won't be quick. We have to be in a position that holds promise for private investment, because more expensive technology and more capital than ever will be needed.

The future of American cities is at stake.

Our job is you.

AMOCO

Book Reviews

Inside the Breeder: What You Can't See Can Hurt You

We Almost Lost Detroit
John Fuller
New York: Reader's Digest Press, 1975; ix + 272 pp., $8.95.

Reviewed by Peter Gwynne

Before I opened *We Almost Lost Detroit,* an account of the partial meltdown of the Enrico Fermi breeder reactor just outside Detroit on October 5, 1966, I was skeptical, to say the least. John Fuller, the author, had to his literary credit such efforts as *Incident at Exeter,* a tale of the coming to earth of flying saucers, and *Arigo, Surgeon of the Rusty Knife*, a profile of the Phillipine faith healer. The book's advance notices were heavy with praise from the establishment of nuclear power critics, most of whom have no specific expertise in nuclear engineering. And the news conference that launched the book quickly boiled (or melted) down to a seminar on the ills of the nuclear industry. Obviously, thought I, this was yet another semi-hysterical tilt at the putative evils of the nuclear reactor.

Then I read the book. It certainly reflects Mr. Fuller's bias against nuclear power. But that bias is not allowed to intrude upon the narrative, which is a gripping, factual account of how technology can go wrong, how small misunderstandings and human errors escalate, and how competent scientists and technologists react to near catastrophe.

Certainly the scene was dramatic. The Detroit Edison engineers who ran the pioneering breeder plant — the first in the world to produce electricity for the public consumption — were suddenly plunged into a fog of uncertainty. They knew that something drastic had gone wrong, so drastic that they were forced to close the operation down. They suspected a meltdown — the melting of some radioactive fuel in the reactor. But they did not know just how serious the accident was.

One possibility they faced in the hours and days after shut-down was that the situation inside the stricken core would deteriorate, leading inexorably to an even more disastrous incident than meltdown: an explosion that would release intensely radioactive isotopes into the atmosphere and ultimately into the densely populated areas of Detroit and southern Michigan. But they could not risk probing the reactor's interior to appraise the extent of the damage. Such efforts could have provoked a fresh disaster by interfering with what might have been a delicate balance of radioactive materials within the core.

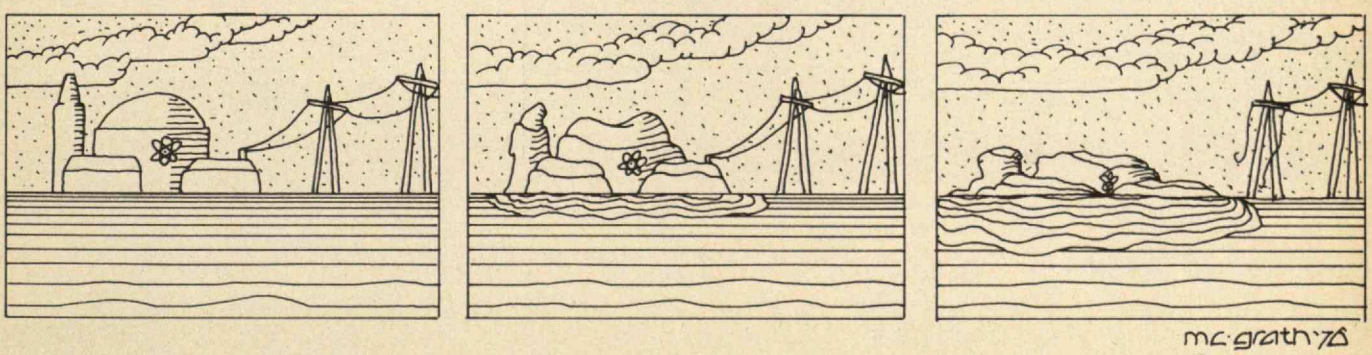
Fortunately, the interior of the plant did settle down, but it was not until months later that experts dared to probe it. Finally, using a remarkable array of indirect techniques, they managed to find the source of the problem: a mangled piece of zirconium metal that had been installed — incongruously, as part of an added safety feature in the plant's original design — and then forgotten.

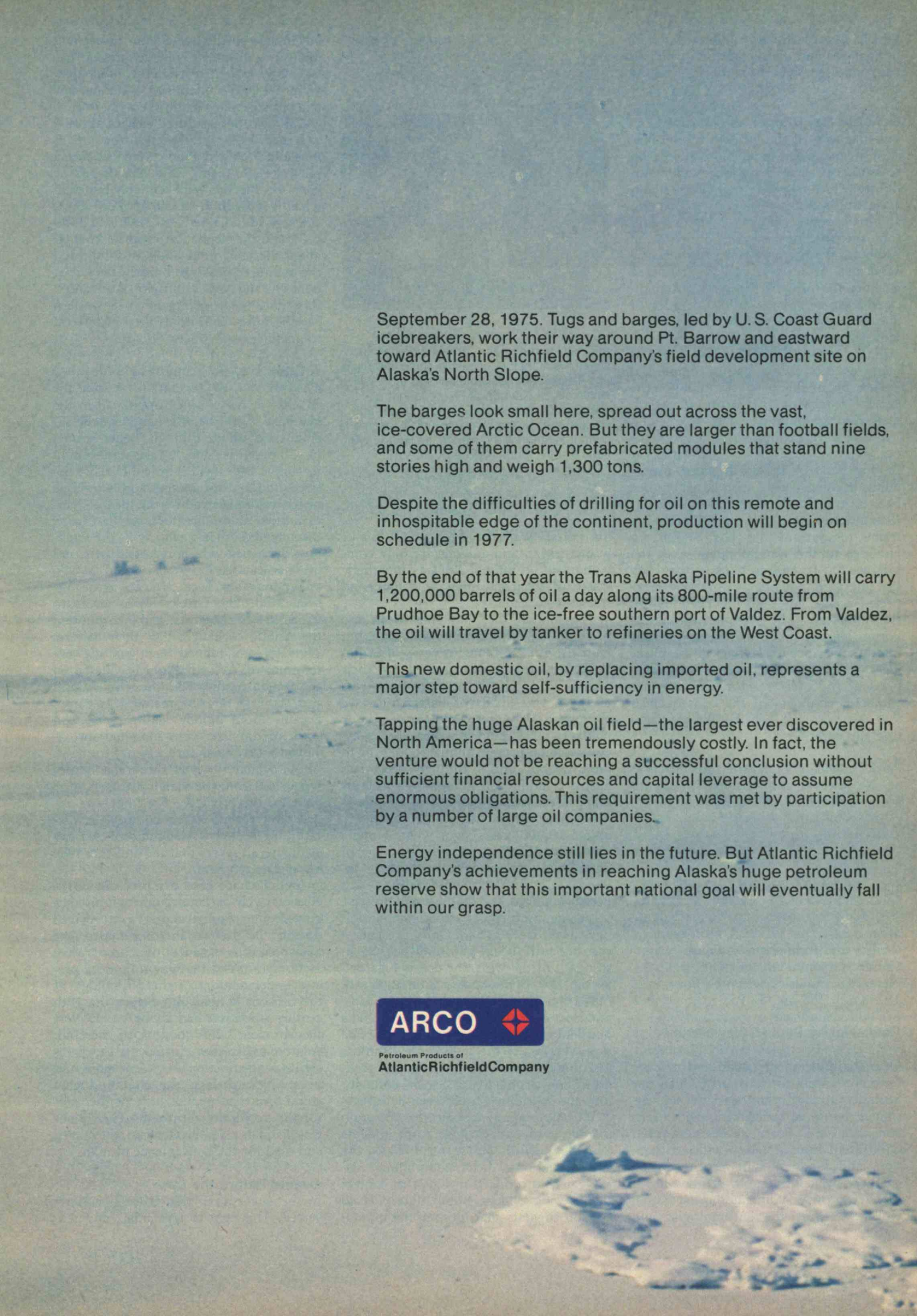
A Meltdown Put Down

We Almost Lost Detroit was published at an opportune time, at least from the nuclear critics' point of view. During the few months before its publication, the nuclear fraternity was debating the circumstances of a more recent nuclear accident which devastated the Browns Ferry nuclear plant near Decatur, Ala., on March 22, 1975. That accident resembled the Detroit disaster in many ways. Although the result was not catastrophic, the mixture of uncertain engineering and human error was uncannily similar.

The cause of the Browns Ferry fire was an unbelievably primitive method of searching for minor problems. Two technicians were seeking air leaks beneath the control room of the plant's two reactors using a naked candle flame. The flame caught a piece of polyurethane foam that the men had used to repair a leak. The polyurethane, which had not been fireproofed, ignited, and despite the efforts of the technicians the blaze spread rapidly. The plant's alarm sounded, the emergency cooling system of one of the reactors activated automatically, and smoke started pouring into the control room. About half an hour after the fire began engineers were forced to close down the two reactors, and to devise makeshift means of pumping water into them to keep the "decay heat" from melting the fuel. Seven hours later, the fire was finally put out. By that time,

(Continued on p. 28)





September 28, 1975. Tugs and barges, led by U. S. Coast Guard icebreakers, work their way around Pt. Barrow and eastward toward Atlantic Richfield Company's field development site on Alaska's North Slope.

The barges look small here, spread out across the vast, ice-covered Arctic Ocean. But they are larger than football fields, and some of them carry prefabricated modules that stand nine stories high and weigh 1,300 tons.

Despite the difficulties of drilling for oil on this remote and inhospitable edge of the continent, production will begin on schedule in 1977.

By the end of that year the Trans Alaska Pipeline System will carry 1,200,000 barrels of oil a day along its 800-mile route from Prudhoe Bay to the ice-free southern port of Valdez. From Valdez, the oil will travel by tanker to refineries on the West Coast.

This new domestic oil, by replacing imported oil, represents a major step toward self-sufficiency in energy.

Tapping the huge Alaskan oil field—the largest ever discovered in North America—has been tremendously costly. In fact, the venture would not be reaching a successful conclusion without sufficient financial resources and capital leverage to assume enormous obligations. This requirement was met by participation by a number of large oil companies.

Energy independence still lies in the future. But Atlantic Richfield Company's achievements in reaching Alaska's huge petroleum reserve show that this important national goal will eventually fall within our grasp.

ARCO

Petroleum Products of
AtlanticRichfieldCompany

the plant had sustained millions of dollars in damages and the reputation of the nuclear industry had been dealt a severe blow.

Deficiencies, Danger, and Doubt

Investigations of the incident by the Nuclear Regulatory Commission offered no reassurances. The Tennessee Valley Authority, which ran the Browns Ferry plant, was castigated for deficient fire protection and inadequate emergency response. And some members of the Joint Committee on Atomic Energy, previously enthusiastic advocates of atomic power, wondered whether the Browns Ferry incident indicated a general laxness in the operation of nuclear plants that was dangerous to the industry and the public. To some observers, this event was merely the worst of many less serious incidents in commercial nuclear plants that have cast doubt on the general reliability of reactors, if not on their absolute safety.

For its part, the nuclear industry points out that no one was injured, either at Browns Ferry or at Detroit; safety procedures, in other words, worked when they had to. And the fact remains that the nuclear industry is the only one subject to extreme regulation that has caused no fatalities to the general public. Yet the message of Mr. Fuller's book — that even the safest of industries can suffer unexpected accidents — has not been lost on the industry. The Atomic Industrial Forum, a group that can in no way be confused with critics of the nuclear establishment, reports, "Mr. Fuller's reconstructions of the early reactor accidents are valuable reminders of the consequences that can still result from insufficient attention and care."

Peter Gwynne is General Editor (Science) of Newsweek *and former Managing Editor of* Technology Review.

Beasts of the Field

Men, Beasts, and Gods: A History of Cruelty and Kindness to Animals
Gerald Carson
New York: Charles Scribner's Sons, 1974; x + 268 pp., $2.95.

Reviewed by Paul M. Newberne

Over the millenia that man and animals have co-existed, we have articulated our attitudes toward the beast world, attitudes that have varied with civilizations and with time. Fear has been balanced with fascination, affection with exploitation, and kindness with cruelty — all clouded by considerable self-deceit. In fact, we know very little about the animal world. Yet, as the entomologist and humanist William Morton Wheeler wrote: "Man and animals are only companions in an infinite and unsympathetic waste of electrons, planets, nebuli, and stars."

Humans and animals have admired one another for centuries. Verbal communication would make their relationship complete. Allen and Trixie Gardner, professors at the University of Nevada at Reno, taught a chimpanzee American Sign Language, and Roger Fouts of the University of Oklahoma is continuing their work. Above, he teaches Ally (*left*) to say "book." (Photo: NOVA)

The human race has learned to use brain power to improve its condition, but animals, after millions of years of evolution, are still largely guided by their senses. When we descended from the trees to the grassy plains of East Africa, we learned to walk erect, and so to use our hands to make and use weapons. We discovered high-protein animal food: how to hunt, to cook, and — through speech and abstract modes of thought — to pass along what we learned.

Animals entered the human economy about 10,000 years ago, when hunters and food gatherers reached the stage of agriculture and permanent campsites. Indeed, cohabitation and taming are perhaps our oldest — and most impressive — accomplishments in experimental biology. *Men, Beasts, and Gods* presents a case in point: the history of the dog. A descendant of the wolf, the dog is regarded as the first domesticated animal. It admired the reindeer hunters' refuse heaps, and social relationships developed. The dog had the nose; the man the eyes. The dog was faster; the man more cunning. The dog defended the camp against predators, he was an agreeable social companion, and in a pinch could even be eaten.

With developing agriculture came grain storage, and with storage came rodents and the need for pest control. Thus, the cat stepped onto the stage of animal history, first introduced in Egypt to control the soaring rodent population. Gerald Carson suggests that, despite the mutual advantages in the association of cat and man, it is debatable whether the cat has any interest in man whatever, other than as provider. Modern-day veterinarians and perhaps many cat lovers would agree.

The next domesticated species appears to be geese: they were interesting companions and provided good eating. "It cheers me to look at them," says Penelope in the *Odyssey*. Pigeons were probably tamed in what is now Iraq in about 4500 B.C., chickens in India between 3300 and 2500 B.C., and the elephant, to some extent, at about the same time. Soon after followed the taming of beasts of burden: the horse, donkey, and water buffalo. And about this time, the cock appeared in western Europe from Asia; it has been of interest to gamblers ever since.

A Duck May Be Somebody's Mother

The practice of vegetarianism and the concept of nonviolence originated in the Far East. With the affirmation of the sacredness of all life came the belief, rooted in Chinese, Persian, Arab, and Hindu teachings, that there is little difference between the souls of animals and man. This belief was reinforced by the idea of reincarnation. Reverence for animals can be documented at least as early as the Egyptian dynasties, which regarded cats and birds as sacred.

Yet man has been as cruel as he has been kind. The Greeks forced bears to dance, set dogs on cats, and incorporated the Asiatic cock fight into their culture. The Romans refined such sadistic entertainment. According to Mr. Carson, in the second century B.C. the whole world was scoured for raw material as games became more bloody and perverse. All sorts of animals were force-fed intoxicants to drive them into a frenzy for fight. Those which survived the arena battles were shot from the seats by archers who paid for the privilege. The limit was apparently reached when Pompey, as dictator, presented a slaughter of African elephants so severe that the audience rose up and cursed him.

Animals have been a source of knowledge as well as entertainment and religious feeling. Animal experiments, revived during the Renaissance, provided the basis for the science of comparative anatomy and led the way to a more precise understanding of the physiology of the nervous system. But before the 19th century scientists had to be careful lest they broached the question of the soul. Anatomical studies blurred the sharp ecclesiastic distinction between man and beast. Nevertheless, the church dogma stood firm that animals have neither personality, soul, nor future life. Their place was fixed forever in Genesis: they lived and died for the convenience of man.

Beasts Before the Law

In the law courts, this attitude was reversed. The right to try, judge, and sen-

tence dumb animals for injuries to human beings goes back to the law of Moses. During the Middle Ages, legal compacts were sanctioned between men and animals. Insects, birds, domestic and small animals — all were expected to live according to law and to be familiar with the statutes. More than 190 cases of beast prosecution have been documented in France, and as late as 1906, a dog could be sentenced to death in Switzerland. The Russians, in keeping with their traditional mode of punishment, are known to have banished a guilty billy goat to Siberia.

The courts eventually took a more sensible position towards animals. In colonial America, humane legislation dates to 1641, when the General Court of Massachusetts adopted a legal code compiled by the Reverend Nathaniel Ward that became known as the "Animal's Magna Carta." Yet, true to their time, the Boston Puritans discarded the saints but not the devil. In the summer of 1692, two dogs were hanged, along with 19 men and women, for refusing to answer an indictment charging them with witchcraft.

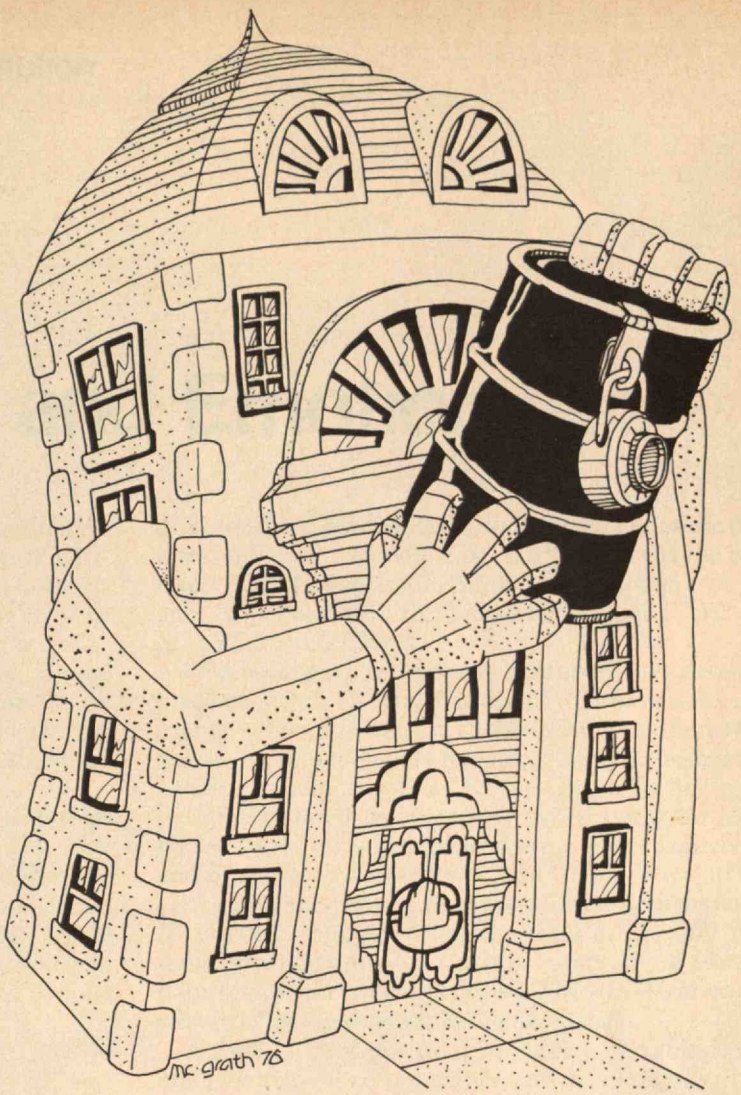
More recent history has seen the establishment of humane societies for the protection of animals against cruelty, whether inspired by ignorance or sadism. The Royal Society for the Prevention of Cruelty to Animals had an enormous impact on the safety of pets and domestic laboring animals in England, and its work soon spread to Ireland, Germany, Austria, Belgium, Holland, and the U.S.

Prominent among early efforts toward humane treatment of animals is the work of George T. Angell, a Boston attorney. Mr. Angell's conscience was aroused in 1868 when two trotters — each drawing two men — were raced 40 miles over rough roads for a purse of $1,000. Both horses died, and Mr. Angell launched an intense crusade which culminated in the formation of the Massachusetts Society for the Prevention of Cruelty to Animals. Today the Angell Memorial Animal Hospital is a leader in the treatment and handling of animals.

Humane societies deserve much credit for their efforts to protect animals from exploitation and cruelty. But the more vocal and restrictive groups threaten to hamper progress of biomedical research and thus — indirectly — to endanger human welfare. Most groups are more reasonable: they recognize the necessity of animal research and limit their concerns to adequate care and freedom from pain.

The matter boils down to a choice. Shall we prohibit animal research and allow people to suffer the ravages of disease, or accept such research in view of its ultimate benefits both to animals and humanity? For most of us, fortunately, the question is rhetorical.

Paul M. Newberne is a doctor of veterinary medicine, and Professor of Nutritional Pathology at M.I.T.



How to Starve a Mechanical Monster

Energy, Environment, and Building
Philip Steadman
Cambridge: Cambridge University Press, 1975; 287 pp., $5.95

New Energy Technologies for Buildings
Richard Schoen, Alan S. Hirshberg, Jerome M. Weingart, eds. Jane Stein
Cambridge, Mass.: Ballinger Publishing Co., 1975; 217 pp., $12; $4.95 paper

Reviewed by John P. Eberhard

It's frustrating for an architect to hear most people talk as if energy conservation and solar energy development were problems primarily for mechanical engineers. Government policies reflect the misconception that buildings use energy simply because they have mechanical and electrical systems. But it should be obvious that those systems — like the buildings themselves — are designed to support and make comfortable some human activity. It's the human need for comfort that requires solutions, not the needs of the mechanical systems. Architects have addressed these fundamental human needs for thousands of years, yet only in this century has it become possible to control indoor conditions within very narrow limits through mechanical and electrical equipment.

Next Steps to Natural Power

Now that we can no longer rely on a continuing supply of inexpensive fossil fuels to power our "overlit, overheated, overcooled, underinsulated, glass-clad prisms" (to quote Philip Steadman), let's not forget why we got ourselves into this bind in the first place.

One reason: we in the architectural profession have forgotten or ignored many of the sensible ways we can adapt buildings to climate conditions naturally. Overhangs to protect windows from the hot summer sun, orienting buildings to capture the prevailing breezes, burrowing our houses into the warmth of the land, and lots of other good notions that Philip Steadman recalls are first steps. The next step is to capture renewable sources of

(*Continued on p. 71*)

Kenneth O. Emery
Woods Hole Oceanographic Institution

Offshore Oil: Technology ... and Emotion

The values and dangers of offshore petroleum production have been described in an enormous outpouring of written and spoken words during the past five years, but misconceptions persist. In this article, I shall present some of my views and hopefully clear up a few of these errors.

To begin with, some have charged that the United States has delayed its own production to first use the oil and gas resources of the rest of the world. The figures for oil and gas production, perhaps unfortunately, show the reverse.

World production of crude oil and natural gas liquids during 1973 totaled about 3,000 million metric tons (one ton averages 7.5 barrels of 42 gallons each). Of this, the United States produced 18 per cent, and the Middle East produced 35 per cent. During the same year world production of natural gas was 1,400 billion cubic meters, the United States producing 48 per cent, and the Middle East 4 per cent.

The total world cumulative production of crude oil from the dates of the initial wells to July 1, 1973, was 39,000 million tons, of which the United States alone produced 35 per cent; for natural gas the figures are 21,000 billion cu.m. and 65 per cent, respectively. So, on an energy basis, the United States with only 6 per cent of the world's land area and 5 per cent of its population annually produces *26 per cent of the world's oil and gas energy,* and during the past century it has produced 40 per cent of the world's oil and gas energy.

The world's consumption of oil and natural gas liquids equals its annual production — 3,000 million tons. The United States, however, consumed about 830 million tons of refined oil products during 1973 and produced only 550 million tons, a shortfall of 280 million tons. This is 50 per cent more than its own production — or, to put it another way, one-third of its total consumption. This deficit was made up by imports principally from the Middle East, South America, and Africa. The United States, however, is not the chief customer of the Middle East and Africa, as the bulk of their excess production over consumption (960 million tons per year) went to Europe and Japan.

Reserves and Resources

The remaining proved resources of oil — deposits known and exploitable by present methods — are 84,000 million tons for the world, but only 4,600 million tons (or 6 per cent) for the United States. Fifty-six per cent of the proved reserves is in the Middle East. For natural gas the proved reserves of the world are 58,000 billion cu.m., of which only 12 per cent is in the United States, and 37 per cent is in U.S.S.R. and China.

"Undiscovered recoverable resources" — deposits of presently economic concentrations that have not yet been found — are estimated at about 150,000 million tons for the world, of which only 8 per cent is in the United States, and 40 per cent is in U.S.S.R. and China. For natural gas, the undiscovered recoverable resources may be 140,000 billion cu.m., of which 9 per cent is in the United States and 36 per cent is in U.S.S.R. and China. If we optimistically lump the proved reserves and the undiscovered recoverable resources of oil, the total is 230,000 million tons, of which only 7 per cent is in the United States. For natural gas, the world total is 200,000 billion cu.m., of which 10 per cent is in the United States.

A final kind of potential resource is the sub-economic one in which oil concentrations are too low to justify extraction even at present prices. These resources are enormous. Most of these deposits are found in strata whose oil is not concentrated enough to permit the development of any oil fields. Some represent the two-thirds of the total oil in oil fields that remains after the more easily producible oil has been obtained through wells; part of this oil is being recovered by secondary methods that involve flushing of oil sands by water and gas drives. Tertiary methods which utilize bacterial activity, chemical reactions, and/or *in situ* heating of the oil-bearing strata also have some promise.

Economic Power of Oil and Gas

The world uses oil at a rate of 1/30 of the world's proved reserves and 1/50 of the world's estimated undiscovered resources of oil per year. If present consumption were to remain unchanged, one might hope that the oil would last another 80 years; however, to hold worldwide consumption down is not so simple. Consumption of oil may be reduced, particularly in the United States — encouraged not by altruism, but by the great problems caused by outpouring of capital from industrialized nations to a few underdeveloped ones from whose land and ocean floor the oil is being produced. The latter are chiefly the 13 members of the Organization of Petroleum Exporting Countries (O.P.E.C.). Listed in order of decreasing 1973 production these are: Saudi Arabia, Iran, Venezuela, Kuwait, Libya, Nigeria, Iraq, Indonesia, Algeria, Abu Dhabi, Qatar, Dubai, and Ecuador. Their total 1973 pro-

Photo courtesy of Tenneco, Inc., Houston, Texas

Dwindling domestic oil supplies and international power politics make a convincing case that the U.S. must quickly develop its offshore oil. But this means more intelligent environmental and governmental policies.

duction was almost exactly 50 per cent of the world total, and their 1973 oil revenue is estimated at $23 billion, which increased to $110 billion in 1974. Curiously, 6 of these 13 oil nations were candidates for $206 million in United States economic assistance funds for 1975. Any tendency toward reduced consumption in industrialized nations is more than offset by the rapidly increasing consumption in the underdeveloped nations that are increasing their industrialization. Ironically, much of this industrialization is promoted by the inflow of funds to some of the nations from oil purchases by the United States, Europe, and Japan, but all underdeveloped nations are encountering internal demands to raise their peoples' living standards.

Nearly all of the oil and gas of the Middle East, South America, and Africa was discovered by geologists and geophysicists from the United States and Europe, but it is on land and ocean floor legally belonging to the nations where the oil is produced. Now, the predictable has happened — all of these nations have raised the prices of their oil as high as possible; some have nationalized (or confiscated) the oil fields and refineries, and others probably will follow.

Oiling a Revolution

The approaching depletion of oil and gas in the present industrialized nations, and the presence of most remaining oil in the areas of underdeveloped and Communist nations is working a profound change in world geopolitics. Oil and gas are now the most important raw materials in short supply; their possession and control is the source of international power. In former ages the same role was played by:

— The silver mines of Laurium that financed Greece's defeat of the Persians and its rise to the Golden Age of Pericles,

— The Iberian Peninsula's gold, iron, copper, silver, and mercury that supported Rome's dominion of the Mediterranean and adjacent regions,

— The gold and silver liberated from the Central American "savages" that initiated Spain's age of affluence until the wealth was squandered on luxuries, and

— The coal and iron that made possible Britain's industrial age.

And, of course, many minerals beside oil and gas have contributed to the United States' dominance in technology.

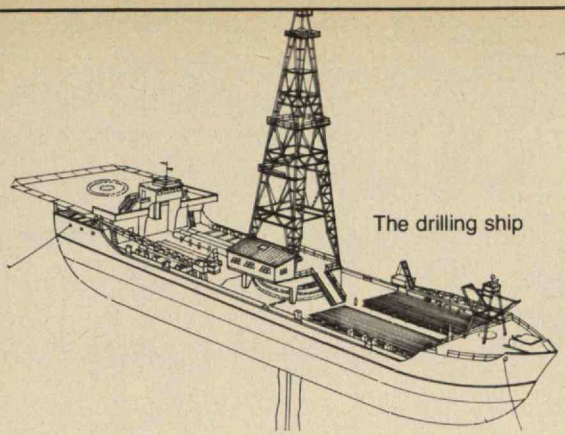
Much of the power of the United States is due to its technological lead over the rest of the world. Perhaps its future power will largely be based in addition upon its ability to grow and export food — a result of both technology and its fortune in having large areas of easily cultivated fertile land. But oil is still an important ingredient of food production, as about ten calories of energy is required for one calorie of consumable food product — to make fertilizer, till the land, process the harvest, and transport and distribute the food. Probably the ratio of oil to total fishery products is only slightly lower.

Alternate Energy Sources

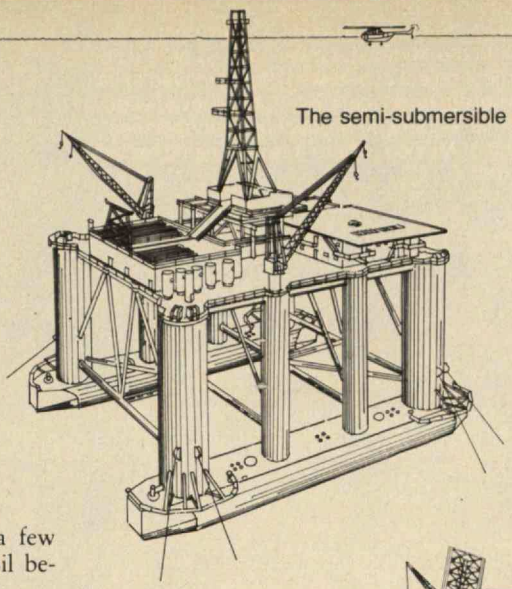
Additional sources of energy are required, for both the short and long term, for the United States to retain a high standard of living and probably even to exist in a changing future. Long-term solutions include extraction of energy from sunlight, tides, wind, and temperature differences found at different ocean depths. These long-term energy sources do not cause progressive heating of the earth's surface as do the burning of fossil fuels or the use of nuclear reactors. But they are so capital intensive that the value of their energy outputs probably would be much less than the interest on the capital investments. Perhaps this limitation will be overcome in the future by much increased prices for energy. Nevertheless, long-term energy sources must be developed if the world population continues to increase and the reserves and resources of fossil fuels continue to become depleted.

The principal long-term energy source may be nuclear fusion, but this may be decades away because of technological problems involved in producing and confining temperatures as high as those of the sun. Nuclear fission, already in use, produces appreciable amounts of energy in stationary power plants, although it now fulfills only a few per cent of the United States' or the world's total energy requirements. A variant, the breeder reactor, may soon come on stream as a means of conserving nuclear fuel. Drawbacks to nuclear energy so far have been high capital costs, environmental roadblocks, safety and security problems, and radioactive waste disposal.

The most evident short-term solutions to increased energy production are the conversion to oil and gas of oil shales, tar sands, and some coal. The world's proved reserves and the undiscovered recoverable resources of oil shale total perhaps the equivalent of 45 million million tons of oil. The world's coal totals the equivalent of 15 million million tons of oil. Estimates for United States' reserves and undiscovered resources of oil shale and coal are 3.7 million million tons and 3.0 million million tons of oil equivalent, respectively.



The drilling ship



The semi-submersible rig

Tapping the Oil-Rich Seabed

Although there are many variations, there are but a few themes which technologists have used to get at the oil beneath the sea.

For drilling in shallow waters, up to about 350 feet, the jack-up oil rig has had a long history in the offshore game, and is by far the most popular drilling unit afloat. Towed to the drilling site with its legs up, the rig then plants its feet and hoists itself up until the platform is above the waves.

As water depths reach 1,000 feet or so, the semi-submersible rig comes into its own. Held in place by massive anchors with mooring lines extending a mile or more, these rigs are now being designed to drill at depths up to 2,000 feet.

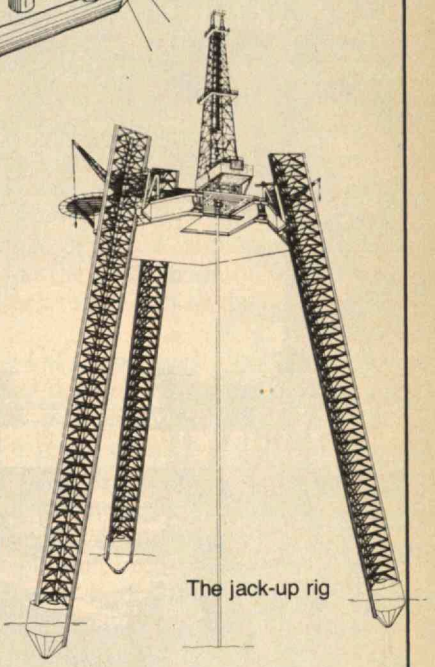
The highly mobile drill ship, with a hole through the middle of its hull, can tap the seabed at depths of 2,000 feet or more. It is also anchored in place, but obtains much of its stability from thrusters, which "sense" and compensate for waves and currents.

After oil is found, however, platforms attached to the sea bottoms must be erected to actually produce a well. In the past, with wells in relatively shallow waters, platforms have been fairly easy to erect and design. However, increasing water depths are forcing the oil industry into massive building projects to produce larger and larger production platforms, now reaching several hundred feet high. Offshore platforms now being built for North Sea operations weigh as much as a World War II battleship and rival the Eiffel Tower in complexity. Because of the increasing size and costs of such platforms the oil industry is experimenting with various new drilling and production systems. Among them:

— Subsea production systems are currently being tested by Exxon, Mobil and others. In such systems wells are drilled through a template structure secured to the ocean floor. If oil is found, the structure becomes a production unit, controlling the flow of oil into pipelines to a surface facility.

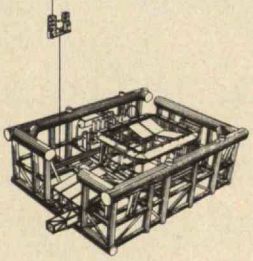
— The tension leg platform resembles a semi-submersible drilling rig that is anchored to the ocean floor by vertical cables, which are under tension at all times. The cables are tuned to make the rig stable during heavy storms. A prototype tension leg platform is now being tested off California by Deep Oil Technology, a Long Beach, California, subsidiary of Fluor Corp.

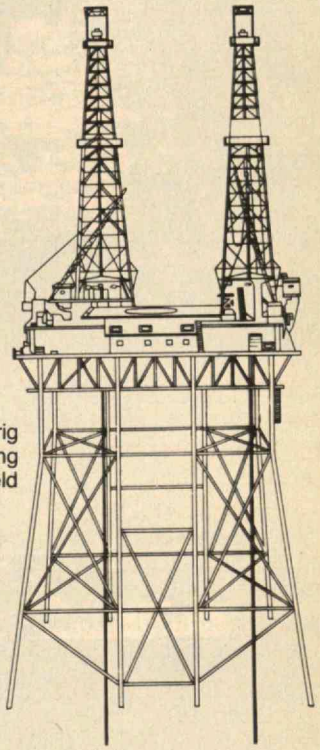
— A "guyed tower" platform now being developed by Exxon may be economically attractive for water depths of 600 to 2,000 feet. The tower consists of a vertical structure resting on the sea floor, deriving its stability from long cables extending outward in all directions and anchored to the sea floor. The tower is "compliant" in that it moves with the waves. Exxon is now testing a one-fifth scale model of a guyed tower platform — 370 feet tall — off the Louisiana coast. — *D.M.*



The jack-up rig

An experimental subsea production system

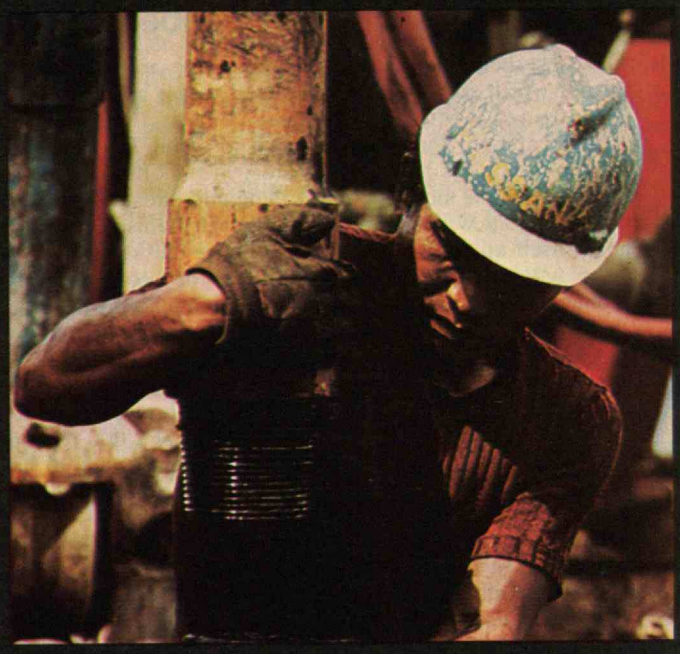


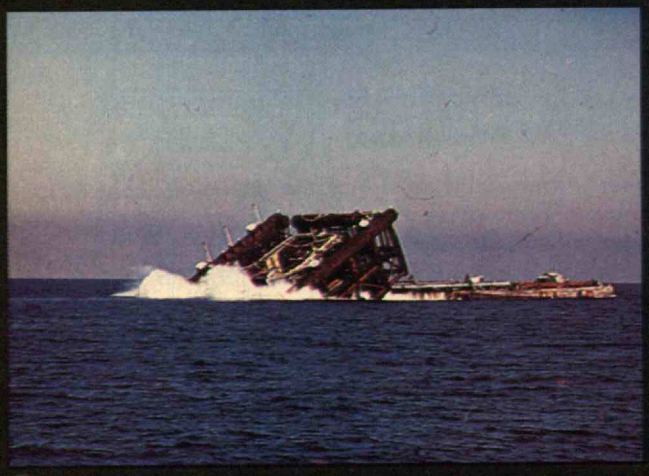


Fixed platform rig for developing a discovered field

Drawings are from "The Offshore Search for Oil and Gas," Exxon Background Series, Exxon Corp.

Yesterday, today and tomorrow offshore: Upper left, a drilling platform in the old fields of the Gulf of Mexico. Upper right, a roughneck drilling for oil in the Mideast. Lower right, a production platform *Brent B*, the largest object ever towed, being moved to its site in the North Sea, where it now operates in 460 feet of water. Lower left, an experimental subsea oil production unit splashes into the waters of the Gulf of Mexico, where it is now being tested. (Photos courtesy of Exxon)





Thus, the total world reserves and undiscovered resources of oil shale and coal may be about 250 times those of world oil, and, for the United States, about 400 times those of domestic oil. Thus the United States has an especially favorable position with respect to the world's oil shale and coal; in fact, the present dominance of the Middle East in terms of oil will be offset by its poverty in oil shale and coal. Now opposing production from oil shale and coal are the higher costs of oil from oil shale and coal than from oil fields, and the environmental restraints on strip mining of oil shale and coal. These restraints exist for coal mining whether coal is to be burned as coal or converted to oil. As a matter of interest, the tonnage of coal mined directly for fuel is nearly equal to the tonnage of crude oil and natural gas liquids now produced annually in the United States and the world.

The Environmentalists

All sources of energy must be developed by the United States as rapidly as possible, but the quickest supplementary energy is likely to come from increased exploration and production of oil and gas from the ocean floor. About 17 per cent of the United States' total crude oil production comes from its continental shelves even though only about 2 per cent of its shelf area has been opened for oil production — for two main reasons: environmental concerns, and government policies and demands for revenue.

The environmental outcry has occurred mainly because of the increasing presence of tar on beaches and the death of shore birds from oil spills. While the Santa Barbara oil spill catalyzed the rise of environmentalism, only three wells and one pipeline accident, from more than 18,000 wells drilled on our continental shelves, have spilled more than 1,000 tons of oil each since 1953. This is a safety factor of 99.978 per unit at this level. In contrast, tanker operations spill about 20 times as much oil annually as does oil production from the world's continental shelves. This ratio is being reduced by increased use of load-on-top tankers, but simultaneously some of the huge tankers needed for economic long-distance transportation of oil from oil-producing areas to oil-consuming ones are becoming old and tired, with increased danger of breaking apart at sea. Thus, we who are interested in preserving the environment should favor increased oil production from the United States' shelves rather than from long-distance-tanker importation.

Some environmentalists have warned that oil spills might lead to an ocean of oil instead of water. However, simple calculations show that even if the total world proved reserves and undiscovered recoverable resources were suddenly added to the ocean, they would constitute a film less than a millimeter thick over the entire ocean surface. The real problem, of course, is that much of the spilled oil concentrates at the intersection of the gaseous, liquid, and solid surfaces of the Earth — the shore zone.

The Politicians and the Oil Companies

Government policies and demand for increased revenues may restrict offshore oil production even more than does environmentalism. As a result of such policies, offshore tracts are small, offered at intervals unrelated to energy needs, and divert company funds away from further exploration and development. At present, oil companies contribute about $2 billion annually to government treasuries in the form of "bonus bids" for undrilled offshore acreage. If drilling is successful, they continue to pay royalties and taxes during all stages of refining, transportation, and retailing. They also serve as involuntary collectors of sales taxes at the gasoline pump, returning about $10 billion in sales taxes to federal, state, and some local governments. Altogether, the revenue to federal, state, and local treasuries totaled about $15 billion in 1972 and the profits to the companies — shared by their stockholders — were about $4 billion. Despite the contrast between the government revenue and the oil company profits, the general public has been led to blame the companies for the high prices of oil and its products. In fact, United States' prices of gasoline are only one-half to one-third the prices in many nations in Europe and South America.

Most interesting of the government revenues from oil are the bonus bids paid for offshore oil rights. These are sealed bids, as though drilling rights are to be assigned to the highest bidder for a particular tract offered by the government; however, the Bureau of Land Management rejects bids that it considers too low. This move is not necessarily profitable for the government, because during the past few years many tracts for which all bids had been rejected were put up again in later sales when they attracted lower or even no further bids from industry.

To better evaluate the oil potential of offshore tracts the U.S. Geological Survey requires oil companies to submit all geophysical and geological data prior to the bidding. In fact, federal permits for geophysical and geological surveys now require the companies to make available all data within 30 days after the surveys — long

before bids are accepted. Thus, the federal government is in a better position than any single company bidder to evaluate the oil potential of a tract offered for bidding. But even this advantage is considered insufficient, and so the U.S.G.S. has been given the task of making fairly detailed geophysical surveys to further evaluate offshore geology. This means that the costs of the government surveys and the companies' detailed surveys to determine just where to drill are added to the consumer's oil and gas bill. Such government measures are intended to reduce the costs of consumer oil and gas, but actually reduce supplies and thereby increase costs. Other examples are: controlled prices of natural gas in interstate trade; controlled prices of "old" and "new" oil; forced sharing of oil produced by well-organized and well-planned companies with other companies that are undercapitalized or inadequately planned; and forced use of scarce and high-priced gas and low-sulfur oil in regions where air pollution is minor. Such regulations are akin to the rent control that limits rentals for apartments but discourages further building of apartments by private enterprise. Subsequently, the government resorts to similar solutions, such as the establishment of a subsidized national oil company and the construction of subsidized housing, respectively.

Crying Wolf

Preservation of the aesthetic environment is a real and worthy concern for all; however, some balance might be struck between early warning of environmental deterioration and the "wolf-wolf" signal caused by emotional and

Uncle Sam Offshore

The federal government began wrestling with offshore oil policy long before current debates on Atlantic and Alaskan outer continental shelf (OCS) petroleum. Since offshore petroleum operations began three decades ago, federal and state involvement in OCS issues has become steadily more complex; here is a look at the tip of the offshore legal iceberg.

The first major policy statement on offshore oil was the Truman Proclamation of September 28, 1945, which responded to oil finds off California and in the Gulf of Mexico. In this proclamation the president asserted the United States' right to jurisdiction and control over "the natural resources of the subsoil and seabed of the continental shelf" contiguous to its shores. America's coastal continental shelves could help to meet the "worldwide need for new sources of petroleum and other minerals," and Truman's policy would provide for the "conservation and prudent utilization" of these resources.

The Submerged Lands Act (May 22, 1953) assigned to coastal states the ownership and management of "lands beneath navigable waters" (up to three miles seaward of the states' coastlines) and their natural resources. It also confirmed "United States jurisdiction and control over resources of the seabed" beyond state boundaries. The Outer Continental Shelf Lands Act (August 7, 1953) restated the nation's authority over continental shelf lands beyond the states' three-mile boundary, and charged the Secretary of the Interior with administering the Act's provisions on leasing of the outer continental shelf "in order to meet the urgent need for further exploration and development of the oil and gas deposits of the submerged lands."

Responding to worldwide concern over continental shelf issues, the Geneva Convention on the Continental Shelf, signed April 29, 1958, attempted to set international policy for nations' jurisdiction, and confirmed that a coastal nation "exercises over the continental shelf sovereign rights for the purpose of exploring it and exploiting its natural resources."

Since these early policy statements, the U.S. has fostered a proliferation of agencies and official recommendations to insure its interests in the ocean's resources. Advisory bodies in this area during the 1960s and 1970s include the National Academy of Sciences Committee on Oceanography, the National Academy of Engineering's Committee on Ocean Engineering (now the Marine Board), and the presidentially appointed Commission on Marine Science, Engineering, and Resources, mandated by the Marine Resources and Engineering Development Act of 1966. This latter commission was known as the Stratton Commission, after its chairman, Dr. Julius A. Stratton (President Emeritus of M.I.T.). In its report *Our Nation and the Sea* (1969), the Commission urged that offshore oil leasing and regulatory policies reflect a rate of development consonant with national economic, political, and military needs.

New government agencies that have dealt with offshore oil issues are:

— The National Sea Grant Program (established in 1966), now part of the National Oceanic and Atmospheric Administration (U.S. Department of Commerce), which was formed in 1970 from the combination of several federal agencies concerned with marine and atmospheric affairs;

— The National Advisory Committee on Oceans and Atmosphere, a review panel for the Secretary of Commerce; and

— The U.S. Senate's National Ocean Policy Study, a major source of hearings and subsequent recommendations on U.S. involvement in the exploitation of marine resources such as offshore oil.

America's growing environmental conscience has recently found some voice in offshore oil, principally from a number of Executive Branch reports on offshore resources and oil spills, from the U.S. Geological Survey and its Conservation Division, which supervise oil drilling and production, and from the Council on Environmental Quality. The National Environmental Policy Act, the Oil Pollution Act of 1961, the Water Quality Improvement Act of 1970, and the Federal Water Pollution Control Act all reflect an awareness of offshore oil. The U.S. Coast Guard now has jurisdiction over oil spill cleanup in coastal waters, and federal regulations prohibit any discharge of oil in the nation's waterways. The National Academy of Sciences released in 1975 its major report, *Petroleum in the Marine Environment,* on the sources and environmental effects of oil spills.

Central to today's debate on offshore oil are:

— The U.S. Department of the Interior's Bureau of Land Management, which sets up leasing schedules for offshore tracts;

— The Coastal Zone Management Act of 1972, which provides coastal planning grants to states for setting up coastal zone management systems; and

— The special Master's report, commissioned by the U.S. Supreme Court and accepted by it in early 1975, which denied to states any legal control over resources of the outer continental shelf.

Offshore oil policy is certainly complex, and, as you can see, the government response has been just as complex. And all this legislation and policy represents only the beginning of the avalanche to follow. — *Bronwyn Hurd, M.I.T. Sea Grant Program*

premature judgments. The tendency of the news media to overstate disasters also creates a permanent bias against balanced judgment. Fears of public reaction to possible killing of bottom-dwelling (benthic) animals by oil spills from offshore production has led the Bureau of Land Management to require base-line studies of benthic animals prior to drilling. This requirement is in spite of absence of evidence that offshore spills have killed benthic animals on the continental shelf, and in the face of evidence of the inadequacy of broad benthic base-line studies. Such benthic studies are limited because of the wide spacing of samples dictated by the huge area of the shelf, the scarcity of competent workers, and the seasonal and secular changes in benthic population.

This fear of massive kills probably originated because of instances of tar on sand beaches, where the biomass is very small, but which are very visible to the public. And the fear may have stemmed from the well-documented effects of spills of refined oil, more toxic than crude, in salt marshes.

Environmental damage to benthic animals also has been feared because of the mechanical silting produced by drill cuttings and pipeline burial. But these disturbances are minor when compared with the silting produced by bottom-trawler fishing. Trawl marks over wide expanses of the continental shelf have commonly been observed from research submersibles. Trawling can throw large clouds of silt and clay into suspension, as observed from airplanes flying above trawlers operating over the mud bottom of some inner shelves. Ironically, it has also been observed that numerous crabs and fish quickly congregate along track marks on the bottom made by vehicle runners and ballast chains; so, one might even conclude that disturbing the bottom, as well as minor spills of oil, benefit rather than harm many benthic animals.

Power Politics

As this discussion has indicated, government bureaus involved in offshore oil are far more interested in short-term financial benefits or publicity and political power than in solving the energy problem. It is time that these policies be changed, because the main short-term source of oil and gas in the United States is its continental shelves. Restrictions and delays have been expensive in terms of oil costs to the consumer. Even now, more studies rather than actions continue to be proposed before production is increased in the Santa Barbara Basin, before we know whether oil and gas are even present beneath the Atlantic continental shelf, and before pipeline shipment from Alaskan oil fields begins.

Great importance has been attached to the issues of who should tax and control oil under the Atlantic continental shelf and potential pollution of the shores and its effects upon tourist trade. But as yet no test holes have been drilled. In the absence of actual drill data only inferences can be drawn from geophysical surveys. These surveys show a structure different from oil- and gas-containing structures known on land. Moreover, economic production from the continental shelf requires oil fields larger than the average on land. Lack of data has not prevented the U.S.G.S. in 1972 from estimating resources beneath the United States' shelves to be about 26,000 million tons of oil and 24,000 billion cu.m. of gas; and then from revising these estimates in 1974 to 8,500 to 17,000 million tons of oil and 11,500 to 23,000 billion cu.m. of gas; and *again* in 1975 to 1,300 to 6,500 million tons of oil and 1,200 to 5,200 billion cu.m. of gas. Until we drill test holes, we won't know whether the resources are zero, very large, or almost anything between these two extremes.

Other Offshore Possibilities

The continental shelf is not the only possible area for offshore oil and gas. Further potential may be present in small, deep marginal basins that border the United States. Some of these basins have become filled with sediments, like the Los Angeles Basin, on which the city is built, while others are only partly filled. One of the unfilled basins underlies the Gulf of Mexico, and this one also contains many salt domes that have deformed overlying sedimentary strata into which they have forced their way. The still deeper continental rise covers an enormous area off the eastern United States, and it may also have considerable potential for future oil and gas production. To date, test wells have not been drilled in these deep seafloor provinces, because the water is too deep for economic production and for completion of oil wells with present methods. But new remote well-completion methods may during the coming decade alter the situation and permit economic recovery of oil and gas from great depths beyond the shelf break.

Offshore Oil: One Card in the Hand

To conclude, the United States is in a serious energy predicament in which demand has outrun supply. Voluntarily reducing demand is not occurring, probably because neither politicians nor consumers understand the problem and its serious consequences. Increased domestic supply is being opposed by environmental roadblocks and by government policies and demands for revenue. The present energy supply is mainly from oil and gas followed by coal, nuclear reactors, and hydropower.

Peak production of oil and gas in the United States has passed, but the continental shelves offer the best apparent chance for a fairly large immediate source of supplementary oil and gas, with the best prospects for the Atlantic coast being structures in the Wilmington Canyon Trough off Delaware and the Georges Bank Trough off New England. Other short-term sources of oil and gas are from inland deposits of oil shale and coal.

Additional supplementary energy in the short term can come from increased use of nuclear fission reactors and perhaps in the long term from nuclear fusion. Wind, tides, waves, and temperature differences in the oceans are considered long-term sources of energy, but ones that will not heat the earth as do fossil fuels and nuclear reactors.

All of these energy sources must be investigated and those that are deemed feasible must be developed rapidly before the options of the United States become limited by continued loss of capital by purchasing oil from abroad.

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Offshore oil promises substantial wealth for the nation and for those who develop it. Sharing this income equably between public and developer is a thorny issue for which several alternatives are now being debated.

Sharing the Offshore Oil Bonanza

Alternative policies for managing petroleum which may exist on the outer continental shelves of the U.S. are the subject of considerable current contention. Both environmental groups and the petroleum industry have expressed dissatisfaction with the present system. Proposed alternatives range from nationalization of the industry to "work obligation permit" programs, which in the extreme approach are simple claim-staking.

The purpose of this report is to analyze the present system and the principal alternatives and their likely consequences. The approach is unabashedly economic; that is, this study concentrates almost entirely on the real income implications of alternative offshore management policies. This focus is consistent with the conviction that offshore oil is *not* basically an environmental issue and *not* basically an issue of shoreside jobs and development; it is, rather, primarily a question of the amount and distribution of the national income involved — the difference in the cost of offshore oil and imported oil and the allocation of this difference between the developer and the public and between the adjoining coastal state and the rest of the nation.

Work at M.I.T. over the last three years on the environmental issues associated with offshore oil suggests that there is very little environmental trade-off between offshore oil production and its alternative. Statistical studies of oil spills have shown that about the same amount of oil will be spilled in offshore production as in importing an equivalent amount of crude.

Analyses of the economics of offshore oil show that the *net* impact to onshore development occasioned by offshore oil is usually very much overrated. For even a very large offshore development, the gross payrolls from on-site jobs and direct support facilities would be only a few score million dollars, very small compared with the several-billion-dollar national income which would result. If the opportunity costs of these resources — the cost of public services, etc. — are deducted, net impact even on a regional scale would be much smaller. In fact, in some cases of rapid development in high-employment areas such as Texas and Louisiana, the net economic impact is claimed to be negative.

Hence the focus of this report is on the economic rent associated with offshore oil; it is a subject which tends to be overlooked by policymakers debating environmental and shoreside economic issues.

To analyze real income, you must first specify whose income is to be analyzed. In the case of offshore oil, analyses of potential income to three groups — the nation as a whole, the developer, the public (i.e., the nation minus the developer) — give the best insight into the management and policy issues involved.

How Large the Pie, and How Divided?

The relationships among these three groups can be illustrated by the pie analogy. Consider the income from offshore oil as a pie whose size represents the amount of that income. The two questions on which to focus are how large is that total pie, and how is it divided between the developers and the public. In general, different offshore oil management policies will affect *both* the size of the overall national income pie and the relative size of the pieces which go to the developers and nondevelopers. One alternative policy might generate a higher national income than another, but the second might give the public a larger share of the smaller pie. The developers and public have common interests in maximizing the size of the pie but are in direct conflict when it comes to dividing that pie. The best solution is for both groups to agree to jointly make the pie as large as possible — and then to divide it in such a way that everybody has a piece larger than he would have had with a smaller pie.

These fundamentals tend to be ignored in public debate about offshore petroleum. Antagonists broadcast income figures without specifying whose income they are discussing, and they set them opposite cost figures which are in fact not comparable. In such a confused squabble for the largest possible share of the pie, the U.S. could easily end up with policies which make the overall pie substantially smaller than it need be.

The Cost of Offshore Oil

What factors will govern the cost of oil from offshore? It has sometimes been alleged that in the absence of royalties and other payments which increase costs, the savings associated with exploiting domestic offshore oil in lieu of buying imported oil can be measured in lower prices to the consumer. If this were the case, the increases in na-

This article is an adaptation by the Editors of *Technology Review* of "The O.C.S. Petroleum Pie," by John W. Devanney, III, published in February, 1975, by the M.I.T. Sea Grant Program as Report Number MITSG 75-10, Index Number 75-310-Nme. Copies of the full report are available at the Marine Resources Information Center, Room 5-331, M.I.T., Cambridge, Mass., 02139, for $2.50. Dr. Devanney is Associate Professor of Marine Systems in the M.I.T. Department of Ocean Engineering.

tional income would automatically accrue to the public, and simple claim-staking could be argued for.

But, in the absence of direct price regulation, this simply will not happen. Even assuming pure competition among offshore leaseholders, the landed price of offshore oil will not drop below the landed price of imported oil unless there is enough domestic production to push all foreign oil off the market — an extremely unlikely event.

The reason is simple. We will always need oil at the higher imported price — about 38 per cent of our consumption at present. Domestic producers need not sell their oil at lower prices, for they know that there are domestic buyers who are paying the higher price to whom they can sell.

However, the fact that offshore oil will not be cheaper does not mean that its exploitation will hold no benefit for national income. The increase in national income associated with a given find is the difference between the cost of imported crude and the cost of offshore oil in that find, multiplied by the amount of the find. That increment of national income will be divided between the public and the investors in the development. The public will see lease payments, royalties, and corporate income taxes which would not occur if the resource were not developed. The investors will see profits in excess of what he would have achieved without the development. The term "excess" is not applied to profits in a pejorative sense; it simply means profits which would not have accrued in the absence of the offshore investment. It is the division of these excess profits between public and developer that is the central issue in the balance of this paper.

The amount of U.S. offshore oil is not yet certain, but deposits in the range of 60 to 80 billion barrels are likely. To estimate the impact of such a resource on national income, we must know the resource cost to the nation of landing the oil. Obviously, even if we find 100 billion barrels of oil, if the cost to the nation of landing that oil is the same as the cost of foreign crude, then the nation has gained nothing. In such a case, offshore oil is, in a very precise sense, worthless.

To address this resource cost question, we have devised an M.I.T. Offshore Development Model and used it over a range of hypothetical offshore discoveries. This model is a computer program which can be used to determine most profitable strategy for developing a specified offshore reservoir and the flows of money and petroleum which will result. The model takes as input three sets of variables:

— *Geologic variables,* including such descriptors of a hypothetical find as the amounts of oil and gas in place; the type of drive; the number of fields and their separation; the permeability, porosity, and thickness of the formation; initial reservoir pressure and temperature; and gas and oil viscosity and density.

— *Locational parameters,* including water depth, relevant distances to shore, and terminal draft limitations.

— *Financial/regulatory variables,* including the landed price of oil and gas through time; the cost of capital; and the lease payments, royalties, and oil and gas allowables if any.

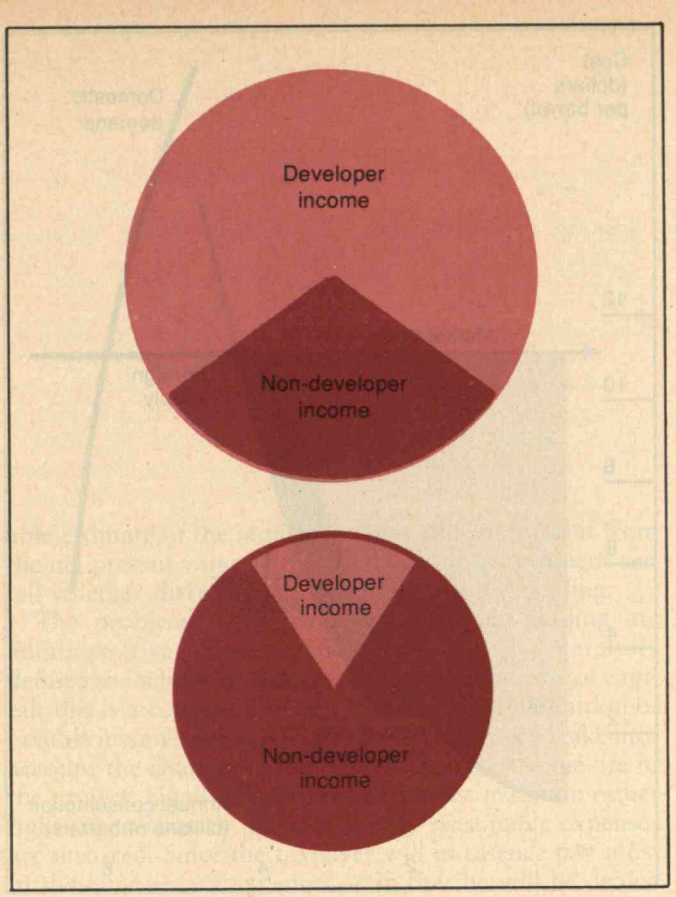
Basically, the program examines a number of combinations of production schedule and transport system and chooses the combination which maximizes the developer's profits.

The model was used to study what appear to be the key variables affecting the costs of offshore oil — the amount of oil in place, distance to landing point, water depth, and platform design wave height. Original oil in place was varied from 50 million to two billion barrels; distance offshore from 25 to 1,500 miles; water depth from 150 to 450 feet. For each set of conditions, the model yielded numbers representing the landed price of oil the developer would have to obtain to break even on the primary oil, not counting gas or secondary recovery revenues.

Basically we found the oil cost to be exceedingly low, even for the most difficult conditions and for small finds. It ranged from 75 cents per barrel for a huge find close to shore in shallow water to about $8 for the smaller finds in the most difficult locations (*see chart, page 45*). On the whole, only finds as small as 50 million barrels in less favorable circumstances would be unprofitable at an oil price of $10 per barrel, and secondary and tertiary recovery could reduce this figure.

The Prospects for Offshore Profits

These results make obvious our conclusion that the loss in national market income associated with not developing a large offshore find on the outer continental shelf could easily approach $7 or $8 per barrel. For the largest hypothetical single find we have studied — two billion barrels in place — this would imply a loss in present-valued national income of around $2.5 billion, the exact amount depending on anticipated sea conditions, water depths, and location with respect to onshore facilities. Clearly, any medium or large find of oil almost anywhere on the continental shelf off the lower 48 states will be cheap oil. The case for the Gulf of Alaska is not very different — the more difficult conditions there would in-



The "pie analogy" for offshore oil. There are two goals in the management of income from offshore oil: to maximize the size of the offshore pie, and to divide it equably between public and developer. While some management plans give the public a larger slice than others, it may be of a much smaller pie.

crease costs about 50 cents per barrel, according to our model.

Combining our results with the projections of the total amount of oil in place on the continental shelf can lead to some estimates of extremely large national income. For instance, the mid-range of the U.S. Geological Survey estimates of offshore oil is 100 billion barrels. If the average cost of this oil were $3, then the difference in national income between developing and not developing this resource is about $225 billion. It is difficult to conceive of any other single activity which could produce such impacts. Even if the total is smaller (most private estimates of offshore oil are lower than those of the U.S.G.S.), we are talking about a very substantial amount of income.

Managing the Offshore Windfall: Bonus Bidding

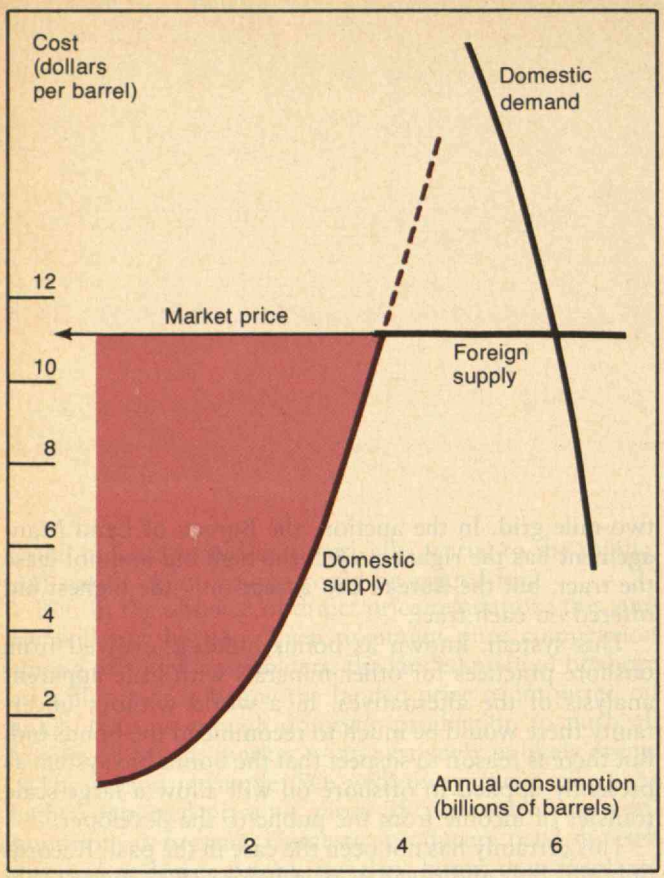
Present U.S. offshore petroleum management policy is based on the issuance of non-exclusive permits for exploration at nominal fees, followed by sealed-bid auctions awarding exclusive drilling and extraction rights by tract. Bids for drilling and extraction rights are on the basis of a fixed royalty on each unit of oil and gas produced and a nominal yearly rental. If a tract is abandoned, it reverts back to the government. Each tract is generally about 5,000 acres, laid out on a rectangular three-mile-by-two-mile grid. In the auction, the Bureau of Land Management has the right to reject the high bid and not lease the tract, but the Bureau can accept only the highest bid offered on each tract.

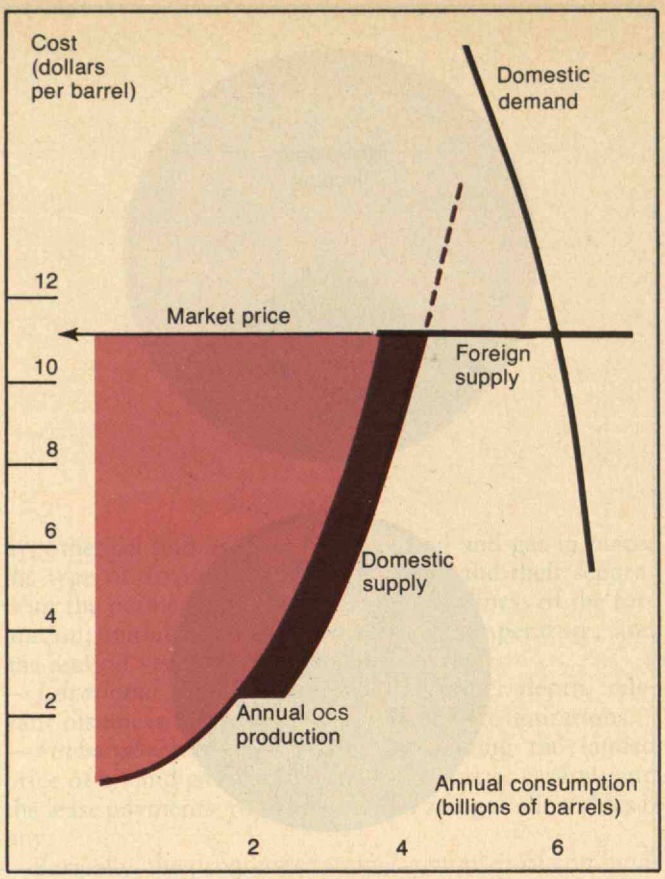
This system, known as bonus bidding, evolved from onshore practices for other minerals with little apparent analysis of the alternatives. In a world without uncertainty there would be much to recommend the bonus bid. But there is reason to suspect that the bonus bid system as presently applied to offshore oil will allow a large-scale transfer of income from the public to the developer.

This certainly has not been the case in the past. Records of bonus bids and royalties paid before 1972 suggest that these fees represented $1.25 to $1.50 per barrel of crude produced. When applied to Gulf of Mexico fields, our offshore development model indicated that the reasonable cost of landing this oil was between $1.50 and $1.75 per barrel. During the same period the price of crude was $3 to $3.50 per barrel. These calculations suggest that prior to 1972 offshore oil was roughly a breakeven proposition (in relation to onshore oil) for the industry and that the public reaped the major benefits.

However, the 400-per-cent inflation in crude oil prices since 1972 may have changed the situation. Consider this example: if, on the Destin Dome in the Gulf of Mexico, Exxon thought it had a 10 per cent chance of finding 1,000 million recoverable barrels, a 20 per cent chance of 200 million, a 20 per cent chance of 100 million, and a 50 per cent chance of coming up dry, the competitive bonus bid should have been about $750 million. But this is an immense amount of money to risk on a 50-50 proposition, so to pool such risks large oil companies commonly bid on tracts jointly; indeed, their banks insist that they do so. But the effect of such bidding combines is to reduce the number of different potential bidders and therefore the effective competition among lease bidders. The result could be a transfer of billions of dollars of real income from the public to the developer.

We will not know for several years whether this has in fact been the government's recent experience, but there are indications that competition is in fact declining. From June, 1973, to October, 1974, the government received a total of $8.1 billion in five major lease auctions. The average number of bids on each of these tracts declined steadily from 5.3 for the first sale to 2.2 for the last. Though there may have been technical reasons to explain the decreased interest in later tracts, any auctioneer would have to feel a little uncomfortable when his offerings attract on the average fewer than three bidders each.





These charts show the demand and supply curves of crude oil to the U.S. and how the U.S. market might be affected by a major contribution of domestic oil from offshore. A portion of today's total U.S. demand (left chart) is filled by domestic oil and a smaller portion by imported oil, the price of which is set by the producers' cartel. The colored line shows the cost to produce the domestic oil consumed by the nation, ranging from about $1.00 per barrel up to the $11.00 per barrel price of foreign oil; domestic oil that costs more to produce than the price of imported oil set by foreign suppliers is not produced, and the market price of all oil is set by the price of the most expensive oil consumed. The tinted area represents the difference between the cost and price of domestic oil — in the largest sense the contribution of domestic petroleum to the U.S. national income.

The effect of a substantial increment of new crude (750 million barrels a year) with a landed cost of $2.50 per barrel — a reasonable hypothesis for a successful offshore oil development — is shown at the right. There is a rightward shift of the supply curve at the unit cost of this new oil. Though the market price of oil remains unchanged, our demand for foreign crude is reduced and there is a substantial increase (solid area) in national income due to the use of offshore oil. In the example, 750 million barrels of $11.00 foreign crude is replaced by a like amount of domestic crude for a net gain in national income of $8.50 per barrel — a total of $6.375 billion a year for the postulated 750-million-barrel find.

There are also problems in preventing communication among bidders in advance of each auction. Although bidding combines do not necessarily imply attempts at collusion, much information must necessarily be transferred between potential bidders in negotiations leading to a combine. And these negotiations may or may not lead to formation of a combine. The interrelations of companies may be complex; on one sale in March, 1974, 19 of the 20 largest U.S. oil companies were in either direct or indirect relationships in combines. Thus the opportunities or, more precisely, the requirements for at least partial communication between bidders are numerous. Even if we assume a concerted attempt to avoid collusion, there is simply no way companies can intelligently choose among bidding combines unless considerable information flows between both actual and potential partners. If the negotiations are unsuccessful, then considerable information may turn out to have flowed between competitors.

We cannot yet know the effects of these factors on the bidding for recent offshore leases, but it is only prudent for the taxpayer to examine alternative leasing systems. Several are available (*see box, p. 44*), and of all the widely discussed alternatives the M.I.T. analysis favored a system called "percentage-of-excess-profit bidding" for tracts on which the government itself has completed exploration.

Percentage-of-Excess-Profit Bidding

Under the "percentage-of-excess-profit" proposal, developers would compete on the basis of the proportion of their profits from offshore operation in excess of a specified base amount they will agree to return to the public in the form of payments to the leasor agency.

Properly administered, percentage-of-profit bidding will not affect a developer's incentives toward efficiency, because the alternatives which maximize the size of the pie before profit-sharing are the same ones which do so after profit-sharing. This alternative does not tax the marginal cost of the oil. If the oil is profitable to sell it will be extracted and sold, for the public's share is taken off the profits. The appropriate range of competitive bids is easily estimated: the government merely figures a reason-

able estimate of the industry's costs and subtracts it from the net present value of the oil. Thus the government can tell whether there is true competition in the bidding.

The problems with percentage-of-profit bidding are administrative. First, profits must be very carefully defined to include an accurate estimate of the cost of capital; this is a concept different from the usual definition of taxable income. Second, one must decide how to take into account the changes in the cost of capital over the life of the project. Finally, the government must maintain rather tight supervision to make sure only reasonable expenses are incurred. Since the taxpayer will in essence pay most of the unnecessary expenses — in that he will be denied profits he is entitled to — there will be temptations for goldplating, kickbacks, overcompensation, and other abuses which are encouraged when the profit motive is absent.

The Issue of Public Exploration

Even after geophysical exploration of an area is complete, there is considerable uncertainty about the presence of oil, and it is amidst this uncertainty that oil companies are expected to bid. Not until several exploratory wells have been drilled are the commercial possibilities of a field certain. One obvious alternative to reduce ambiguity is to go after this uncertainty directly, reducing the risk to oil companies and, in compensation, expecting them to offer larger bids.

Hence a public exploration scheme, under which the government would bear the risk of both geophysical surveying and exploratory drilling; it would make all information public, and bidding would then commence under strict antitrust and anticombine rules. Operators without the large capital bases of the major oil companies could take their information to banks and financial institutions and attempt to arrange financing. Large oil companies would know that independents could do this and would be forced to maintain their bids to allow for only modest profit levels.

The major objection to public exploratory bidding is summarized in the statement of one oil company executive: "A government that can't run a post office can't run an exploratory drilling program." However, this analogy may be unfair, for one may assume that the government would farm out the exploration and drilling work, much as it does defense contracts, through competitive bidding. The same talent available to industry for exploration would be available to the government, and a better analogy might be, "A government that can/cannot run an air force can/cannot run an exploratory drilling program." (Insert the predicate of your choice.)

Though in theory a government-run exploratory program would be as effective as a privately-managed program, what little empirical evidence we have is less reassuring. Several authors have commented on the Bureau of Land Management's inability to predict the results of offshore lease sales. Post-mortem comparisons of pre-sale estimates with actual high bids indicate that the government's estimates, though they are meant to be minimum acceptable bids, are in fact much too low, usually by a factor of three or more. And on individual tracts there are discrepancies in both directions, often by factors of ten or more. Even more worrisome is the Bureau's inability to pick out which petroleum tracts are ultimately judged most valuable by the industry. In the October, 1974, sale only three of the ten tracts receiving the highest bids were also in the top ten of the pre-sale estimates. In defense of the Bureau, it should be pointed out that the Gulf of Mexico, where these sale tracts were, is an unusually difficult area in which to estimate petroleum prospects. Structures tend to be numerous and small rather than few and massive, as is probably the case in many other offshore areas.

Risking Elderly Widows' Pensions

The other basic argument against public exploration is an ideological one — a feeling that the government should not be in the business of risking elderly widows' pensions in the offshore oil game. The taxpayers' risk under this drilling proposal would be roughly $1 billion per year; geophysical exploration costs, to which the government is now committed, are minimal in comparison.

Let us assume for the sake of argument that a government exploration program would cost $1.5 billion per year. Since the government received about $5 billion last year in bonus bids, a 30 per cent increase in these bids would be necessary for the taxpayers to "break even." There are reasons to believe that this would indeed happen. For one thing, bids should be increased by the amount that the bidders would have otherwise spent on exploratory drilling. This assumes effective competition under the present system; if there is not truly competitive bidding now — probably the case — bids would go up even further under a public program.

Another argument offered for exploratory drilling is environmental — the public need not commit itself to production until it has ascertained the environmental risks of developing a formation. For example, explora-

How to Bid for Offshore Rights

Several systems have been proposed to replace the present "bonus-bid" method of assigning leases on offshore oil prospects to developers. Of these, Professor John W. Devanney III of M.I.T. opts for "percentage-of-excess-profits" bids (*see p. 42*). Other proposed arrangements include work obligation permits and various forms of royalty bidding.

The Work Obligation Permit Plan

Under the work obligation permit plan, developers would submit exploratory and provisional drilling plans for a given tract. The government would choose the developer with the most aggressive, best-considered plan, and the developer would then be responsible for agreed-upon amounts of royalties and/or lease rentals. Under this system, used currently by the Norwegians and the British in the North Sea, the great bulk of any economic rent would be transferred to the developer, and a portion of this rent would be returned to the public in the form of corporate income taxes. Of the possible methods reviewed here, this is clearly the most favorable to the developer.

Administering this method to maximize national income depends on the skill and honesty of administrators. There are temptations for prospective developers to submit work plans which represent over-development of the resource so they will be judged the most aggressive, and administrators will have to be wise enough to recognize such over-development and refuse it. The decisions to be made in choosing the "best" work plan are necessarily judgemental, and they are an open invitation to the influence of special interests and even to corruption.

But beyond the possibilities of incompetency or corruption which may result in loss of national income is the basic fact that most of the economic rent goes to the developer. Professor Devanney concludes that work obligation permitting is clearly not desirable, from a nondeveloper point of view. Indeed, as soon as it became clear that economic rent was associated with North Sea oil, the British and Norwegians moved away from this practice.

Royalty Bidding

Royalty bidding involves competitive bidding on a share of the actual gross revenues — generally a percentage of market value — associated with the resource. This method has long been used in state sales of rights, and the federal government experimented with it in the Gulf of Mexico in 1974.

Compared with bonus bidding, royalty bidding transfers some of the risk prior to exploratory drilling from the developer to the public. This helps maintain competition among bidders, for large amounts of up-front capital are not necessary, and the need for large bidding combines disappears.

However, there are other problems. While the method could theoretically give most of the revenues from offshore oil to the public, it could also reduce the total size of the offshore oil pie. This is because the royalty bid, unlike the bonus bid, affects the developer's marginal expenses. For instance, if a developer overestimates production from a certain tract, he will freeze himself into a royalty bid that makes it unprofitable for him to develop the smaller, and thus more expensive, oil find that is actually made. He will refuse to develop it, and the national income will suffer. This risk may especially affect secondary and tertiary production from a tract; such oil will be more expensive than primary oil but still less costly than foreign crude.

Proponents of royalty bidding offer two possible resolutions of this dilemma — re-leasing and renegotiation. The former proposes that if a developer decides not to produce a tract he must turn it back to the government, with all equipment intact, and the government may lease the tract anew, presumably to a different developer at a lower royalty. This would discourage expensive techniques to enhance oil recovery, because the original leaseholder may choose merely to take out the flush production before releasing a tract back to the government. This will be costly to the public, since processes for secondary and tertiary recovery of oil must begin early in a field's life to be most effective. There is also the possibility of excessive administrative costs associated with the negotiations necessary for re-leasing.

Advocates of renegotiation propose that if a developer feels he cannot develop a field at his bid royalty, he should be able to present his evidence to the regulatory body which should be empowered to grant him a decrease if it finds his presentation viable. The obvious problems here are in the regulatory body's verification of the developer's data. The capital-intensiveness of offshore oil makes any estimate extremely sensitive to the cost of capital, and that information is often confidential.

Other potential problems introduced by renegotiation include temptations for developers to "goldplate" a project since additional expenses could come off the royalty — i.e., out of the public's pocket. A developer might deliberately bid high initially in order to obtain a tract, anticipating that he will renegotiate later; and he might go through a whole series of renegotiations as his costs for enhanced recovery techniques begin to appear.

Some have suggested a compromise between bonus bidding and royalty bidding, in which developers would enter a "high" fixed royalty plus a bonus bid of up-front payments. This would decrease the size of bonus bids and aid competition, say its advocates. Unfortunately, this presents the same can of worms as straight royalty bidding.

Installment bonus bidding has also been suggested. This means a developer would pay his bonus in three installments — immediately, after three years, and after five years. He could surrender the lease before the last two payments if things failed to work out. But this presents the same pie-reducing problems as royalty bidding; if a developer originally bid $600 million and after exploratory drilling found oil worth only $350 million, he would abandon the tract rather than pay the final installments even though national income would be increased by $350 million if the find were developed.

There are advantages, however, in installment bonus bidding. There is an automatic re-leasing provision, which could assure that tracts were re-opened for development; and the marginal costs of the oil are not affected, which means that the developer has incentives to invest early in enhanced recovery.

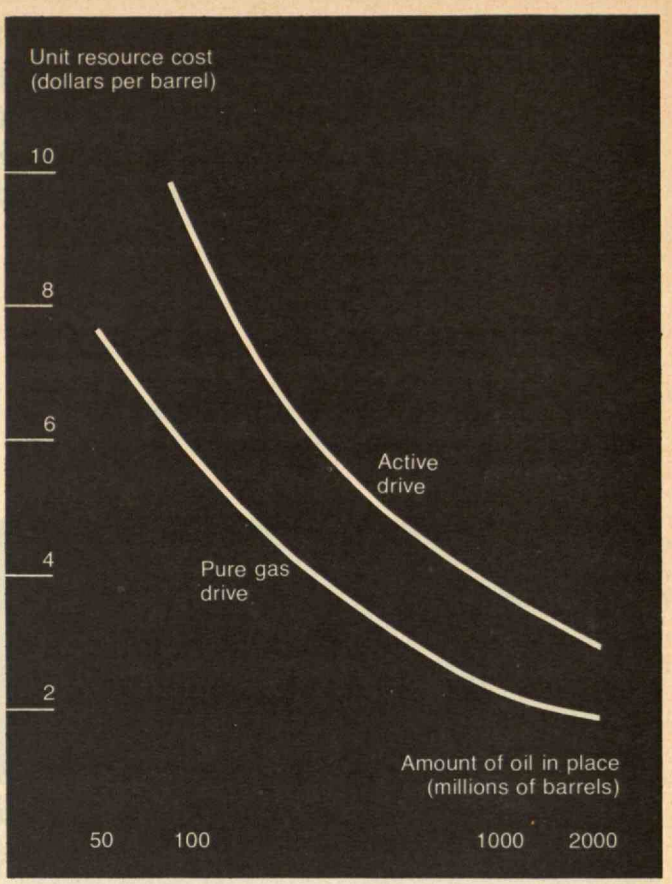
However, the massive amounts of up-front money involved in even a one-third installment payment of a bonus bid will probably still frighten away many bidders. And many bidders would increase their total bonus bids considerably, knowing that they could thus avoid paying additional installments.

tory drilling of one field in Santa Barbara revealed shallow deposits in a highly faulted, unstable reservoir. If there were public exploratory drilling, the nation would have had the option of closing these wells and leaving the field undeveloped.

A final argument for public exploration assumes a degree of wisdom and leadership on the part of government. If we were to have strong public management of offshore drilling, we might be able to put ourselves into the position of being able to boycott Arab oil for a year or more. This would be expensive, requiring considerable overdevelopment and extensive storage facilities; and it would require a drastic change from present practice of using oil as soon as it is available. But it is worth considering.

In general, the petroleum industry has strongly opposed public exploratory drilling. This seems unusual, because it is a case of industry refusing public funding of its own research and development aimed at reducing uncertainties in its investment. How many industries have clamored for public funds on the grounds that risks are too great for the individual company? Public exploratory drilling would be against industry's interests only if it were so effective that present bids are shown to be at below-zero-excess-profit levels.

The ideological argument against risking public funds simply states that the country as a whole should not incur risks which an individual company or group of companies is willing to incur. There are arguments that offshore production will be delayed because the process of development must be interrupted for bidding between the exploratory and production phases. It is also argued that exploratory wells will not be drilled with production intended, in contrast to the industry practice of turning exploratory wells to production use. But such inefficiencies may be marginal — delays may be only a few months and exploratory wells are fairly inexpensive. There may actually be economies, because public exploratory drilling might place its wells more efficiently than oil companies which must frequently place separate wells on separate tracts, all of which are underlain by the same structure.



A computer-based offshore development model has been devised and used at M.I.T. to study the probable unit resource cost of offshore oil if and when it is exploited. This chart shows one estimate of cost for a range of quantities of oil in place under two possible reservoir conditions; the figures are based on a development 75 miles from the oil landing site, in 300 feet of water with a platform designed to withstand 75-foot waves, drawing from a reservoir at a depth of 10,000 feet. The authors emphasize that the cost depends critically on the size of the reservoir and can be as low as $2.00 per barrel.

How Quickly the Bonanza?

Whatever leasing method is chosen, there remains the problem of scheduling lease offerings. At one extreme, the government could act like a profit-maximizing monopoly, rationing leases at a rate to maximize its revenue. At the other extreme, it could offer the entire outer continental shelf tomorrow.

Accelerated programs could possibly reduce government revenues and transfer real income from public to developer. This is why:

— Additional production of petroleum could lower prices, decreasing the value of the tracts to the investor. But, as we said earlier, this is not probable because prices would in fact go down only if offshore oil forced all other oil off the market. It can also be argued that the lower prices would represent merely a transfer of income from the government to the public — from one pocket to the other — with no ultimate loss in real income.

— The petroleum industry would be unable to expand to exploit all the leases.

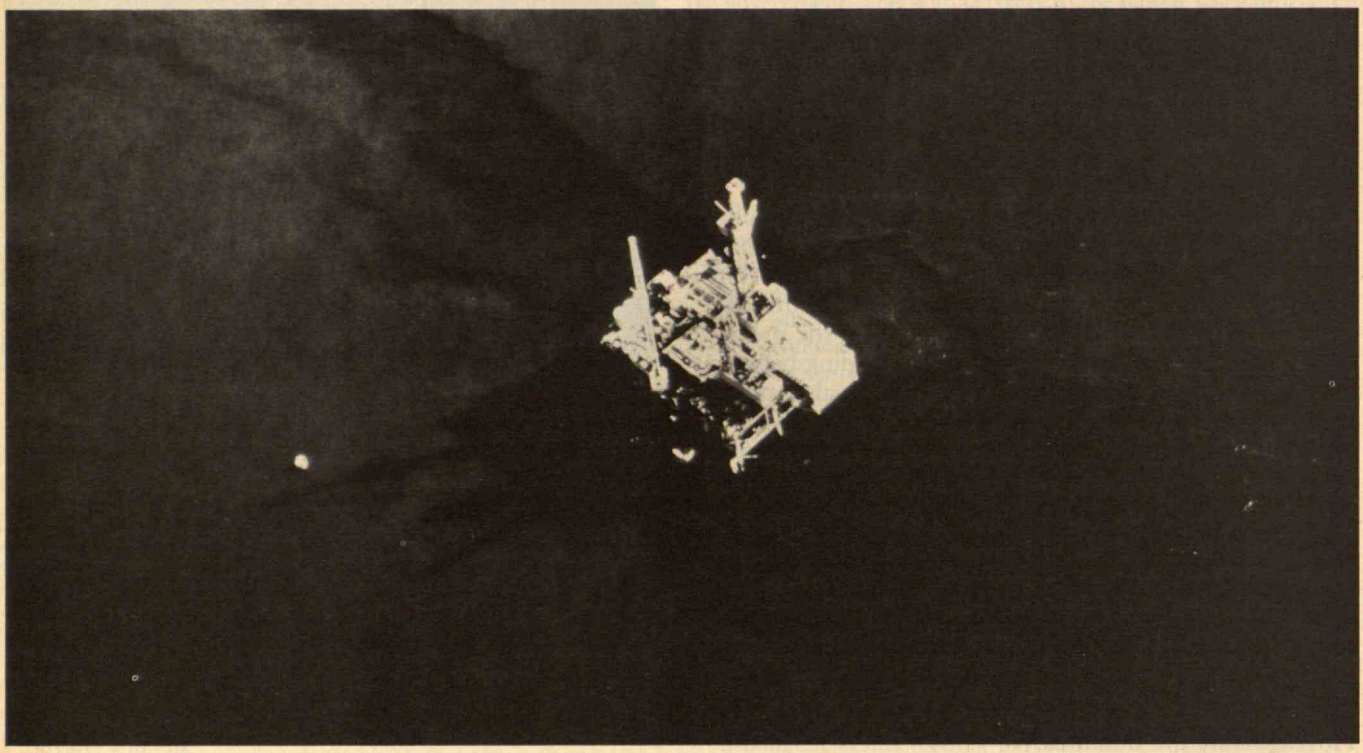
— Maintaining competition would be difficult if the limited number of bidders were offered a large number of tracts.

But from the point of national income — and this means the public *and* the developer — the government should not hold back on any prospects if by holding back it actually slows the development of offshore oil. If there is undeveloped oil which costs less than foreign oil, national income will suffer because the cost of capital will continue to rise. If capital expansion problems can be overcome through either excess-profits bidding or public-exploratory drilling, a compromise lease schedule can be used in which leasing is geared to the maximum rate at which the offshore industry can expand. This would cost the developer, and ultimately the public, more, but it need not be a massive transfer of economic rent.

As long as one believes the cost of capital will rise faster than foreign crude prices, there is a strong argument for greatly expanded offshore leasing; and to prevent a substantial transfer of economic rent to the developer and his suppliers, this means a switch to excess-profits or public-exploratory bidding.

Slicing up the offshore petroleum pie will be a tricky business; but if the knife is sharp — that is, if the debate is informed — and if the slicing is done in clear public view, there should be quite a piece for all concerned.

Offshore drilling appears to be a much messier means of acquiring crude oil than importing. But uncertainties in future technology and current statistics cloud the analyst's crystal ball. While we can make estimates, our knowledge of oil spill movement and effects is less than perfect.



Santa Barbara, 1969, and its aftermath. On January 28, 1969, well number 5, platform A, off Santa Barbara, Calif., penetrated a pool of very high-pressure oil and blew out, despite preventive devices. As a last resort, to stop oil flow, the drilling pipe was dropped into the hole, the oil escaped and the well was capped. However, cracks opened in the ocean floor, and the onshore breeze drove a considerable amount of the million-gallon spill onto California beaches. Because of the high visibility of the beaches, and the dramatic injury to oil-soaked birds, the spill received wide publicity, but many scientists contend that the marine environment in the area was affected very little.

The Atlantic coast is different from the California coast in two important respects: first, there is an offshore prevailing wind, unlike California's onshore breeze, which makes spill beachings less likely; and second, the geology of the Atlantic coast is such that fracturing is unlikely. (Photos courtesy of the Massachusetts Audubon Society)

Robert J. Stewart
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M.I.T.

Oil Spills and Offshore Petroleum

The possible consequences of oil spills from offshore production has been the central issue in debate over the recent expansion of the federal government's offshore leasing program. Controversy has arisen mainly because of lack of knowledge about the complicated interplay between oil-related pollutants and the life forms that inhabit the seas. In our ignorance, we have developed a range of conflicting, yet equally well-meaning opinions.

Proponents of increased leasing, for example, point to the apparent harmony of offshore petroleum production and life in the waters of the Gulf of Mexico. In their opinion, offshore oil is a simple economic question. Opponents contend that low-level, chronic pollution may not produce a perceptible effect in the short term, but may yet be of great importance in the long term. Laboratory and field studies have suggested that such low-level pollutants may cause damage only as they are concentrated in higher and higher levels in the biological food chain. These dissenters judge Outer Continental Shelf (OCS) petroleum production to be but another nail in the ocean's coffin.

Uses of Spill Data

But as Stephen Moore has said elsewhere in this issue, these are fundamentally unresolvable issues at present. Perhaps we can make better progress by looking for insight into subsets of the problem, without tackling the whole thing.

Certainly other sources of petroleum-related pollution exist besides offshore production. These sources will always be present, since we are not about to do away with our petroleum-based economy. Maybe some perspective on offshore oil can be gained by comparing the spillage associated with a new offshore production operation with other oil-pollution sources. This may provide some idea of how big a coffin nail we're using. Presumably, carpet tacks and small finishing nails are preferable to railroad spikes — that is, if offshore oil spills are minimal compared to other sources, it may be better to worry elsewhere.

It is also possible to make some estimates of the magnitude and frequency of oil spillage from offshore production. While we can't estimate long-term environmental damage with predictive data, we can, in any particular application, make some qualitative judgments of short-term importance by comparison with known spills of similar size in similar climates.

Finally, we can use spill data to look at some issues of equity: to what extent will a local region be forced to bear the brunt of the (primarily non-market) disadvantages of offshore oil, while the nation as a whole shares in the benefits? For example, if a coastal area is likely to be impacted by an oil spill, then it may be necessary to establish a way to reimburse local citizens for any losses. Further, drilling in certain OCS regions appears less likely to have adverse effects upon some regions than upon others. Perhaps we should lease such low-impact locations first, other considerations being equal.

Our studies at M.I.T. over the last three years have aimed at shedding light on these questions.

Nature of the Oil Spill Beast

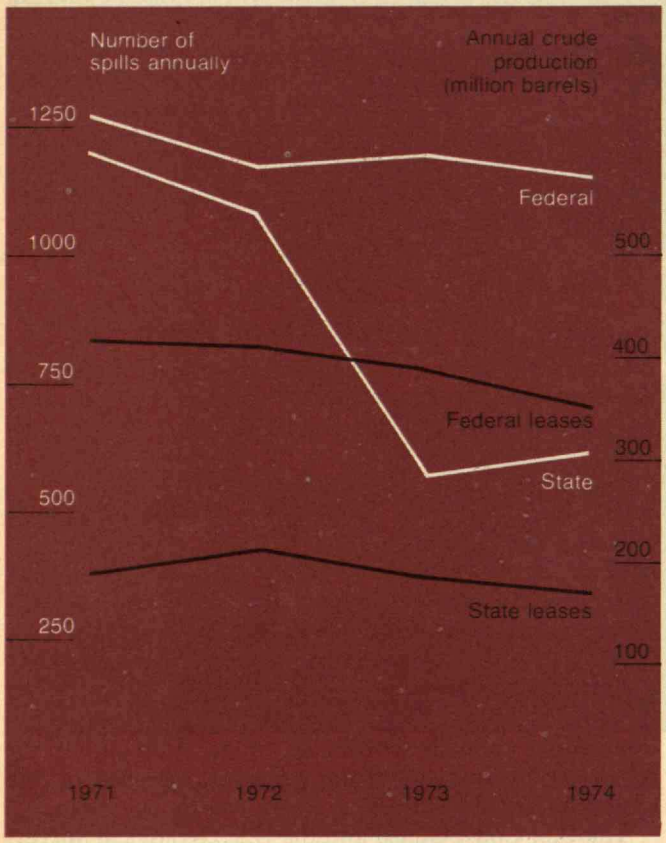
In our petroleum-based economy, oil finds a variety of routes into the marine environment:

— It can be found mixed with partially treated urban sewage;
— It is associated with industrial wastes;
— It is intentionally discharged from ships in the process of removing accumulated water and cleaning storage tanks;
— It is accidentally spilled from a variety of sources; and
— Oil seeps into the sea from a few natural sources, such as "Coal-Oil Point" in California.

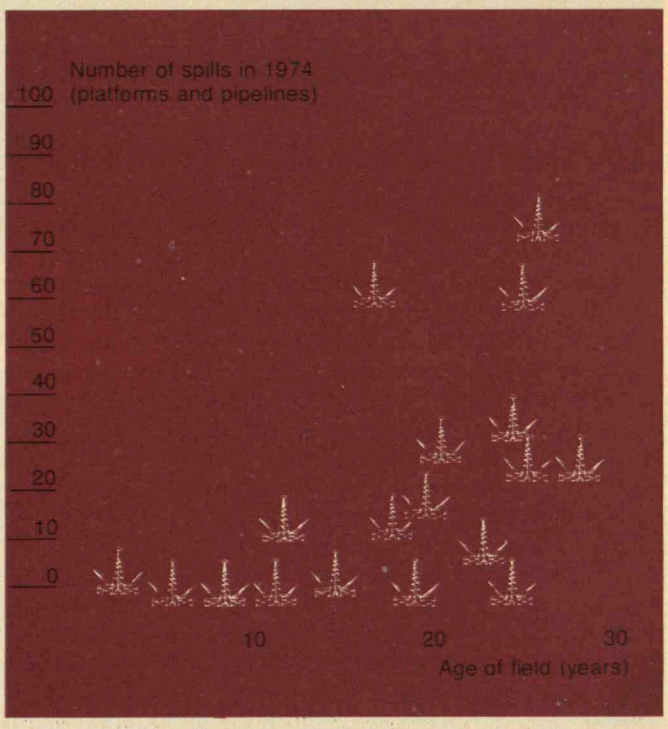
Many have speculated on how much oil is contributed by these sources, a typical estimate being about one billion gallons annually worldwide. I place little faith in the reliability of such numbers, however, because of the enormous simplifications necessary to produce them.

The U.S. Coast Guard and the U.S. Geological Survey, however, have kept fairly close track of the number and type of accidental oil spills in U.S. waters, making it quite feasible to analyze precisely at least the oil that enters the sea through inadvertent oil spills. The table on page 56 gives a rough summary of the U.S. experience with accidental oil spills during two recent years. Such figures usually show a remarkable consistency in the number of spills from one year to the next for any given category. Conversely, the volume spilled from one year to the next varies wildly. Consistent spill numbers are expected because oil-related activity is fairly constant from year to year. Inconsistent spill volumes result from the extreme variance in any given spill's magnitude.

As we can see from the graph, oil spills from offshore production accounted for a full one-fourth of all U.S. oil spills in number, but only about three per cent of the volume spilled. If comparison is limited to petroleum industry sources in coastal and offshore waters — e.g. tankers, offshore platforms, refineries, terminals, etc. — then offshore production activities account for about one-half



Oil spills in state waters showed a marked drop in 1972-73, while spills in federal waters remained substantially the same. And these changes took place with no marked changes in oil production and no noticeable changes in technology. These figures indicate that factors other than technology, such as vigilance, are primary affectors of oil spill numbers.



A scatter diagram of spill numbers versus age hints that the older the field, the higher the spill rate. These figures are for the 24 largest fields off Louisiana. A break seems to occur in the data at 15 years, with fields older than this having markedly higher spill numbers. This may indicate corrosion or wear as a cause.

of all the spills in number, and about one-fifteenth of the volume. The discrepancy between the fractional number and the fractional volume suggests that offshore oil operations are either much more susceptible to having little spills, or they are much more carefully monitored.

It is tempting to look at these figures and jump to the conclusion that offshore oil production is, indeed, a negligible source of oil pollution. However, this may not be the case: offshore oil accounts for a relatively small portion of the total U.S. consumption of crude oil — only about ten per cent — so, we may be subjecting ourselves to increased oil spillage for a relatively modest amount of oil (*see charts on p. 57*).

Imports or Offshore?

To determine the relative advantages of offshore drilling, consider the alternative to offshore oil production — increased imports: would more or fewer oil spills occur if all offshore oil were supplanted with imports? While certainty is impossible, useful insights can come from comparing the spillage associated with importing crude oil with that observed for offshore production.

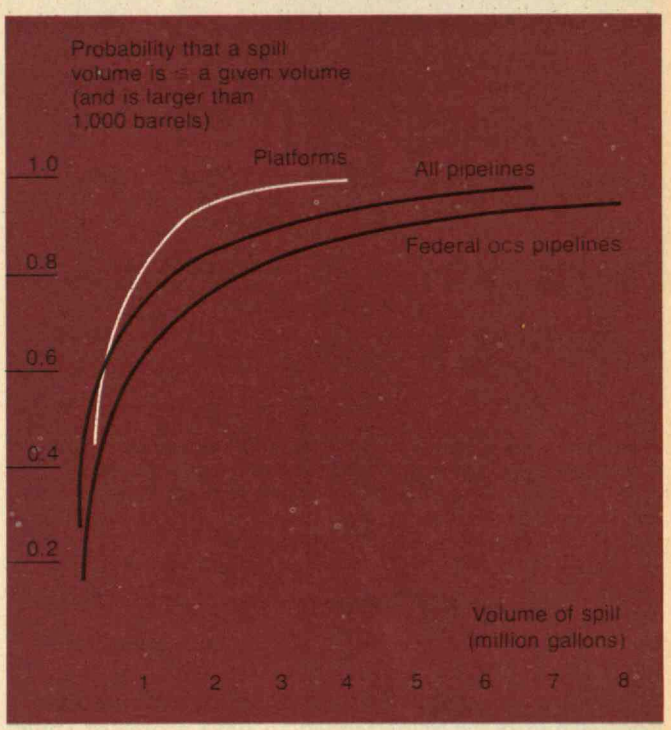
Because the U.S. Coast Guard's data on oil spills were not ideally suited to this inquiry, it was necessary to draw a number of inferences. In particular, we had to find coastal regions in which the flow of imported and extra-regional crude was very simple. There are two such regions — New England and the Mid-Atlantic. In New England, the bulk of all crude oil traffic is destined for the Portland, Me., pipeline terminus, for eventual transport to Canadian refineries. Almost none of the crude oil is

transhipped intra-regionally by tankers or tank barges. In the Mid-Atlantic region, imported and extra-regional crude oil is brought into New York Harbor and into the Delaware River, where in either case it is off-loaded to local refineries.

The comparison *(see page 57)* of oil spills in these regions with those in all the offshore production regions of the United States, principally southern California and the Gulf of Mexico, strongly suggests that the spillage associated with importing the equivalent of all offshore production is much smaller than the spillage from producing the oil offshore under today's conditions in the U.S. This, despite the fact that all offshore oil is brought ashore by pipeline, which is commonly considered to be the preferred mode of transport.

It might be argued that the differences in the number of spills result from variations in the different regional spill monitoring programs. For example, offshore production appeared to produce many more small spills than other sources, and this could prejudice the comparison. However, a more detailed examination of the data shows that offshore production contributed about four times as many spills over 1,000 gallons as did importation, and spills of this size are nearly certain to be reported irrespective of the region in which they occurred.

This discovery is rather unfortunate, because it implies a direct conflict between policies to maximize U.S. income by developing offshore oil and policies to minimize the amount of oil spillage by importing oil. There is, of course, no way to resolve this conflict without personal judgements.



The volume probability distribution for large offshore spills shows spills from platforms are unlikely to exceed 3 or 4 million gallons, while pipeline spills might be as large as 7 or 8 million gallons.

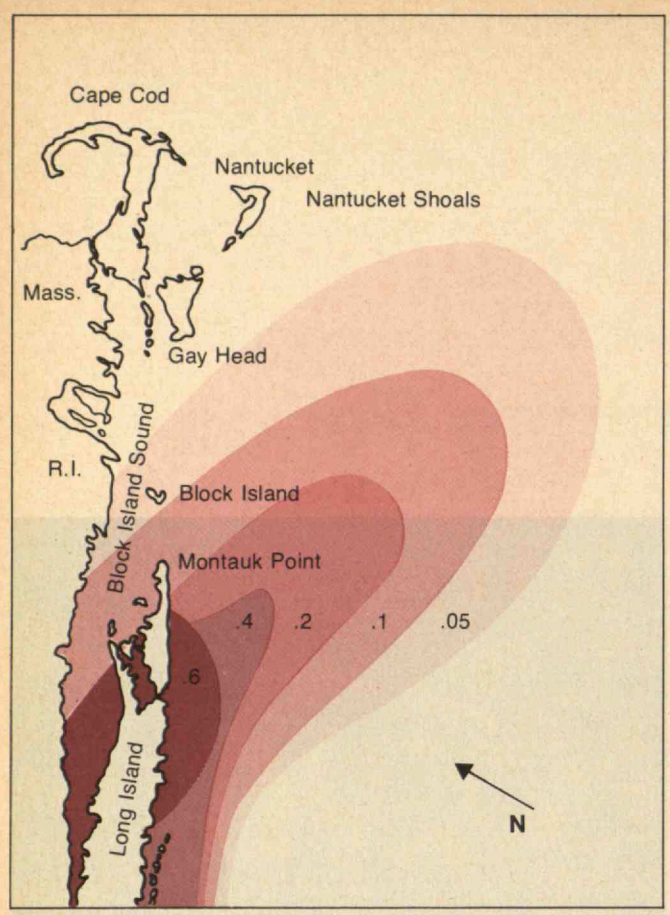
Historical Data and Prediction

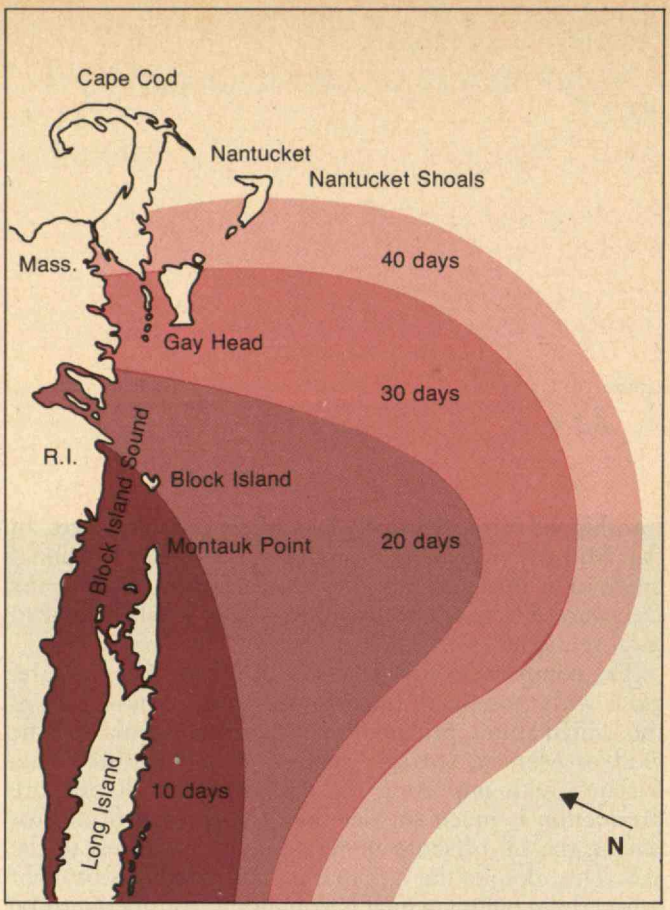
Before future events can be predicted from historical data, several questions must be resolved: Does the historical data pertain to the problem at hand? Is spill prevention technology so static that past records describe the spillage to be expected in the future.

There is no simple way to analyze the data and get a yes or no answer on the impact of new technology. However, some insights can be gained from the data regarding oil spillage, and these insights can be used to suggest an answer.

For instance, as the graph on page 48 shows, there has been a sharp drop in the rate of spillage from platforms in state waters in recent years. Prior to 1973, there were 6.1 spills per million barrels produced from state waters, and afterward 3.3 spills were recorded, a number comparable to the federal spillage rate, which remained remarkably steady around 3.0 spills per million barrels. Since modern technology is limited primarily to new construction, and since there has been little new construction in state waters, the most plausible explanation for these results would appear to be that the supervision of daily operations has been improved. It seems most unlikely that the spill reduction results from technological innovation. This interpretation of the nature of the oil spillage problem is consistent with a number of other studies that have emphasized how important are the managerial aspects of oil spill prevention.

Improving spill prevention technology might be indicated if older developments tend to have more spills than new ones. A graph of the 24 largest fields of Louisiana comparing the age of the field with the number of spills in 1974 does yield a correlation between age and spills, but one that does not necessarily promote technology as a





These contours show the probabilities (left) and times to shore of oil spills released to the south and east of Long Island, New York, in the summer. As can be seen, oil spills in areas 10 to 20 miles southeast of the island present the greatest danger of landing, and would do so within ten days.

cause of reduced spills (*see p. 48*). There seems to be a break in the data at about 15 years: fields less than 15 years old tended to have almost no spills, with few exceptions, while older fields tended to have scores of spills. The abruptness of the break suggests that if the underlying cause is, indeed, associated with the age, then that cause may be something related to corrosion or wear. One would expect evolutions in technology to induce a more gradual change.

However, this age-dependence does not prove that age caused the spills. Many other parameters are highly correlated with the age of the field, any of which could be the real culprit. For example, the Coast Guard data might not be as complete as one would wish. The more remote offshore developments might have been the least carefully scrutinized. Since older fields are closest to shore this hypothesis suggests that the data collection method, and not age, produced the age-spill relationship. (If we diagram the distance offshore versus spill incidence, we find that fields more than 22 miles from land are also very unlikely to have oil spills!) Also, the sample of fields is not guaranteed to be representative of all offshore developments. In fact, the sample chosen tends to have only 1.5 spills per million barrels produced — far less than the average rate of 3.1 — so we can be fairly suspicious of any attempt to draw very firm conclusions from these data. (Unfortunately, we have not yet had a chance to construct the more representative sample obviously possible.)

Where do the Spills Occur?

The U.S. Geological Survey's data can also be used to identify the source of the spillage within the subsystems comprising an offshore production platform. The results of an investigation by Computer Sciences Corp. for the Environmental Protection Agency indicate that the spillage tends to occur in the expected fashion if aging were an underlying cause.

The gathering net (the subsea pipelines connecting outlying production platforms to a central gathering point), the gas-oil separator, the oil-water separator, and local storage facilities combined to account for about three-quarters of all the spillage observed, both in volume and in number. These subsystems account for most of the plumbing in an offshore operation, and they are subject to either external corrosion from the sea water, or internal corrosion caused by the gas/oil/water mixture, or a combination of both types of corrosion. These systems also have active components such as pumps and sensor-regulated control systems, which are subject to failures unless properly maintained and systematically replaced.

The data on spills over 42,000 gallons, depicted on page 58 for offshore platforms, gives a hint of future age-related problems. A survey of the stated cause — taken here from the U.S.G.S. data — suggests that fires, hurricanes, and subsea blowouts have in the past accounted for nearly all the large spills. Some of these spill causes have been remedied through improved management. Plat-

forms are now shut down and abandoned during hurricanes, and blow-out preventers are mandatory to stop the flow of oil from a subsea well if surface piping is breached. Spills associated with fires are still prevalent, however, and this is a problem not easily solved. (Oil is under medium-to-high pressure in most of the flow systems, so even a small leak could project spilled oil or gas to nearby ignition sources. Once ignited, the fire can be extremely difficult to control and extinguish.) Spills associated with other causes have been rare in the past, but the one spill listed as being caused by a structural failure suggests that this may not always be so. Indeed, the "hurricane" category might be considered as a kind of euphemism for a structural failure under survival conditions, which suggests that almost one-half of all large spills have been caused by a structural failure of one sort or another.

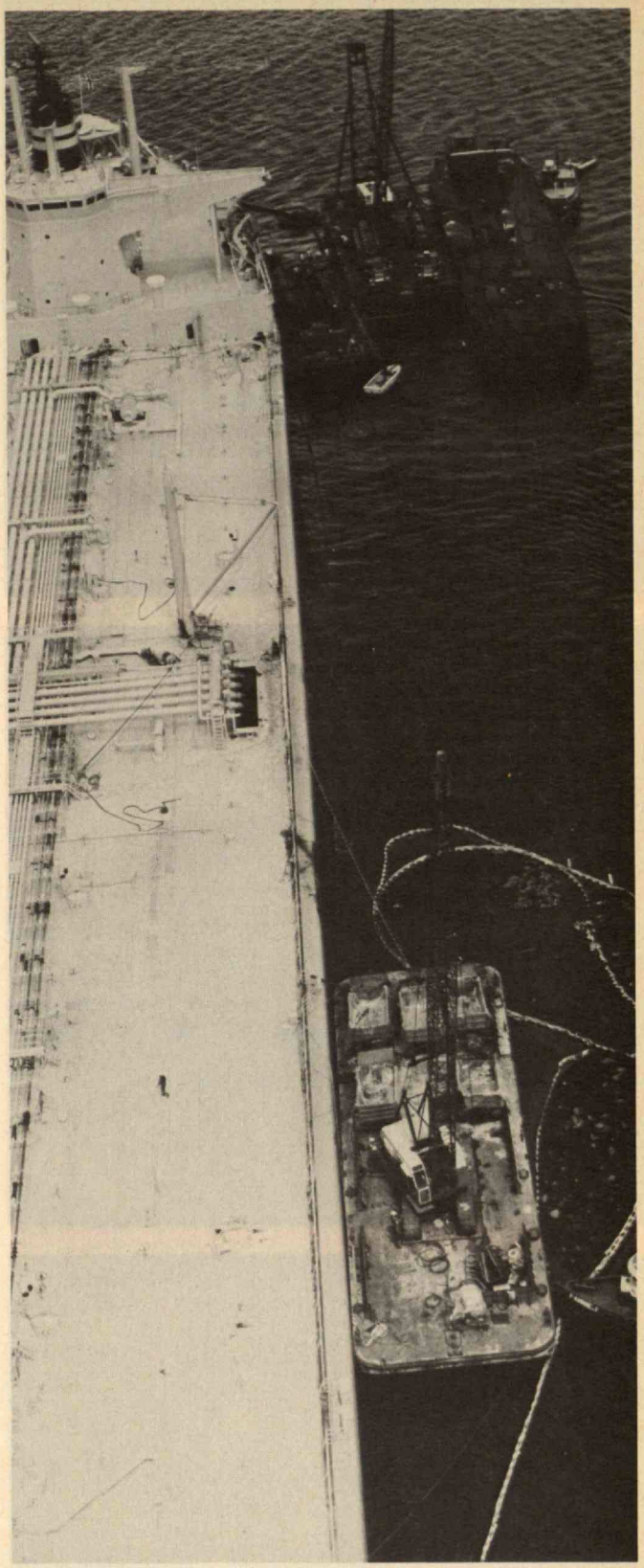
Certainly the age-related degradation of permanently installed marine structures is a topic of considerable interest among the classification societies — Lloyds, the American Bureau of Shipping, etc. — and it is not difficult to see why. Unprotected steel can lose as much as one-twentieth of an inch per year to corrosion in the oxygen-rich splash zone where waves wash upon it, and one-fiftieth of an inch per year in the subsurface zone. A particularly perplexing problem is how to inspect offshore platforms to ensure they are still structurally sound after years of exposure. This problem becomes more and more exasperating as the water depth increases. However much ingenuity is being applied to the problem. As one example, research is presently underway at M.I.T. on indirectly measuring the condition of the platform through its vibration response.

Fugure Rigs

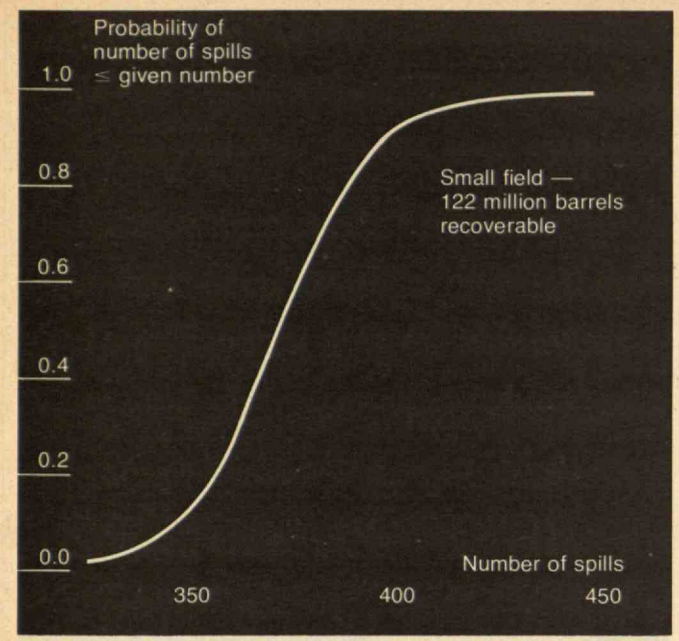
Deeper waters and waters subject to more violent storms will necessitate the principal changes in future offshore petroleum developments. It appears that two approaches will be used: first, designers will scale up the size of the structure to accomodate the new conditions; and second, they will make more extensive use of subsea units — units mounted on the bottom that are accessible only with deep-diving submersibles. A typical deep-water development of the future might consist of one large central structure housing the operators and serving as a central collection spot for the production of a large number of outlying subsea units, each of which might house five or six producing wells. In shallower water, less than 500 feet, a development might consist of a few large surface structures, each of which would contain a large number of wells, provided the petroleum reservoir was deep enough, perhaps 8,000 feet or more, to allow efficient use of directional drilling techniques.

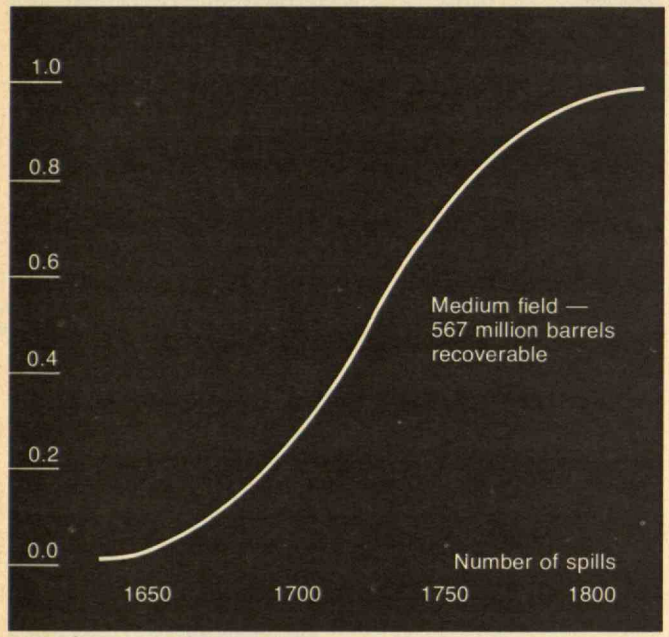
To determine whether such developments will be more or less likely to have oil spills than their present-day counterparts, consider the likely ramifications of the features described above. Developments based upon multiple subsea completion units are likely to have as much piping exposed to the sea as present developments lying off Louisiana. Developments based around two or three enormous platforms are likely to have far less subsea piping.

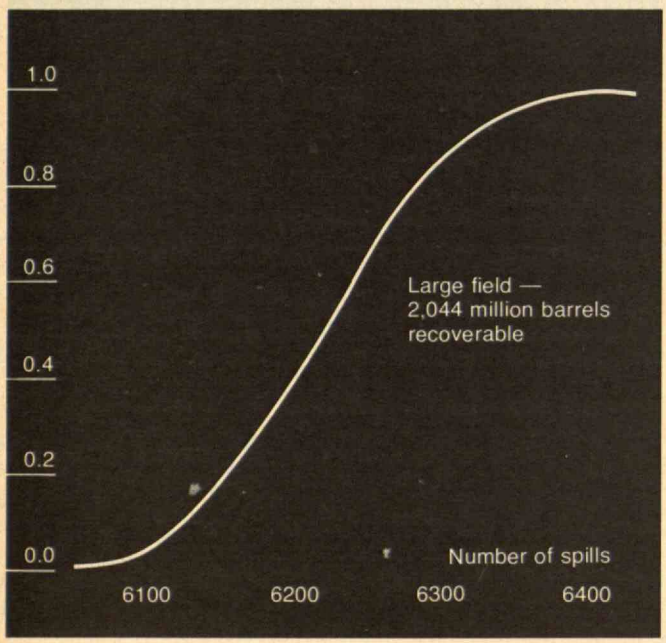
There may be fewer wells per reservoir in the future due to the higher cost per well, since the number of wells required to produce a field is a function of the reservoir characteristics, coupled with the cost of adding more



Cleanup operations around the tanker *Tamano*, which spilled more than 150,000 gallons of number six fuel oil off Portland, Maine, in 1972. To determine the spills from offshore oil versus imports, the author compares the crude oil spilled in such straightforward importation areas as New England, and that spilled in offshore operations, such as in the Gulf of Mexico. He suggests that "the spillage associated with importing the equivalent of all offshore crude is much smaller than the spillage from producing the oil offshore under today's conditions in the U.S." (Photo courtesy of Coastal Services, Inc.)







The likelihood of given numbers of spills from small, medium and large offshore oil finds is charted at the left. For statisticians: the author assumed that the spills were generated by a Poisson process whose governing parameter, usually thought of as a mean spillage rate, was treated explicitly as a random variable. That is, instead of performing a classical analysis of the data in which the best estimate of the governing parameter, a Bayesian analysis was performed in which a number of underlying parameters are accommodated, each particular value being given a weight appropriate to the assumptions about the nature of the generating process, the initial weighting applied to the parameter, and the data from field observations.

The chart on the facing page shows probabilities of a given number of large offshore spills (over 1,000 barrels) for small, medium, and large offshore finds. The rate of pipeline spills is proportional to throughput of oil and similar to historical experience for combined federal OCS pipelines and coastal pipelines.

wells. However, this number cannot be reduced too much before the physical properties of the reservoir begin to dominate the economics, thereby limiting further reductions in the number of wells. This suggests that the basic plumbing of a modern day development will not evolve significantly — there will still be a good correspondence among the number of valves, the amount of piping, and the size of the oil/water separators, for example. The things that will change are the structures upon which this equipment is mounted.

If the apparent importance of age in the spill generation process is accepted, despite the possible uncertainties discussed above, the important question becomes the ability of the next generation of platforms and production equipment to bear the test of 15 to 20 years of exposure. The practical engineering aspects of the problem seem too overwhelming to expect significant improvement. Certainly the equipment and structures will improve to a degree, but a sharp change in the nature of these systems is not to be expected. In short, today's historical data should give some valuable clues regarding the future.

How Many Spills?

Because the data show the number of spills per million barrels produced to be a consistent figure, production volume might be a useful "exposure variable" to use in oil spill predictions. However, the strong relationship of spills to age indicates that a number of variables must be plotted if a predictor of great accuracy is to be developed. To my knowledge, no one has performed this multiple analysis. However, in our past studies, using the production value as an exposure variable we have computed some interesting results.

For example, with this variable as our basis, we have predicted the total number of spills at a particular development over the life of the field. If these estimates are correct, and if our earlier remarks about age-dependence are correct, then the bulk of these spills will occur in the last few years before abandonment of the field.

The graphs at the left show our analysis of the total number of spills that might be expected for offshore *small* (122 million barrels recoverable), *medium* (567 million barrels), and *large* (2,044 million barrels) finds. The small find would be about the size of a large Gulf of Mexico find; the medium find would be about the size of the

largest Gulf of Mexico find; and the large find would be about as big as the large fields discovered in the North Sea off Great Britain.

How Much Spilled?

So far I've concentrated upon spill numbers, rather than amount spilled in these several hundred to several thousand spills. The great variability in spill sizes does not simplify the problem. Most spills are little nuisance spills of one or two gallons. However, most of the oil is spilled in a few massive spills. Thus, there is no single number that can provide us with a description of the oil spillage.

The problem can be divided into two parts: first, prediction of the total number of spills large and small, as above, gives some idea of the "drippiness" of the development; next, prediction of both the number of *large* spills over the life of the development, and the "probability distribution" governing the size of any given large spill, gives an understandable measure of the spill problem. While this doesn't predict the environmental impact of oil spills, it is an improvement over the usual technique of calculating some nominal average spill whose only unique property is that it is very unlikely to be observed in any given situation. The approach described above can make the problem both graphic and concrete.

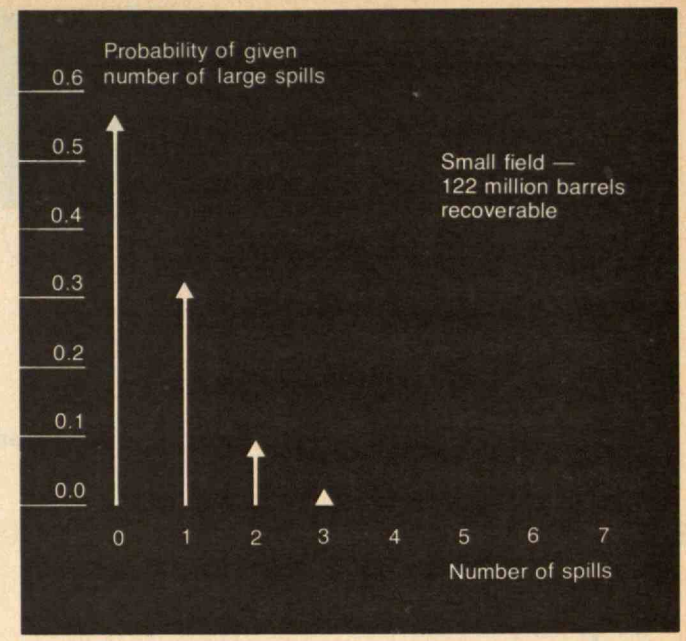
The data upon which the large spill predictions have been based, shown on page 58, were acquired from the U.S.G.S. and the Coast Guard. Arbitrarily defining a large spill as 42,000 gallons and above, we calculated the anticipated number of large spills for the life of the field, assuming that all crude production is brought ashore via subsea pipeline. The prediction takes the form "there is a y chance of x number of large spills."

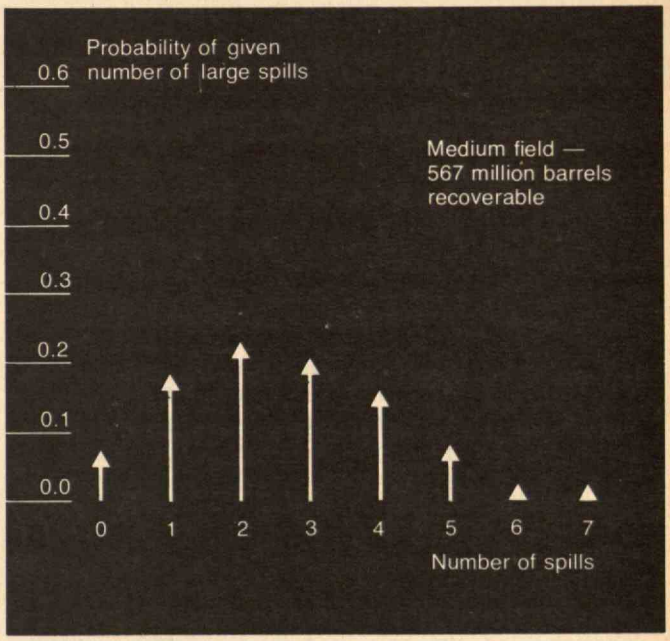
As you can see from the graphs at the right, we found that the small offshore find is likely to have zero or one large spill, with probability near 0.9, while for the larger finds the probability of so few spills diminishes rapidly. In fact, the findings indicate a better than 0.7 chance of two or more large spills at a large Gulf of Mexico find, and a 0.9 chance of more than five large spills from a substantial North Sea find (over the life of the development).

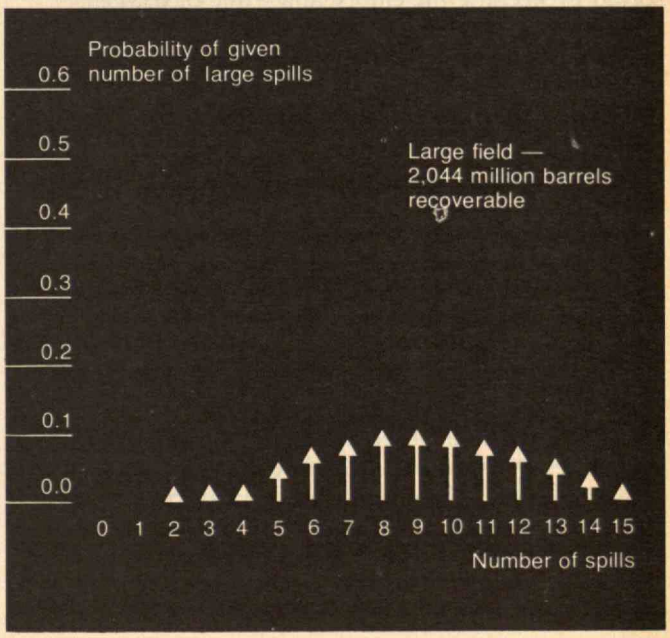
Analysis of the U.S.G.S. and Coast Guard data indicates that spills from platforms are very unlikely to exceed 3 or 4 million gallons, while pipeline spills might be as large as 7 or 8 million gallons (*see p. 49*). Notice also that the median spill from any of the three categories is in the vicinity of 300,000 gallons with the pipeline median spill being smaller than the median platform spill. It seems unlikely that these volume predictions will bear the test of time as well as the predictions of the number of spills because the volume spilled from a pipeline can be greatly reduced through increased monitoring of the pipeline pressure and flow. Some of the larger spill incidents in our data represent leaks that went undetected for periods of weeks. This type of problem is readily amenable to modern technological solutions.

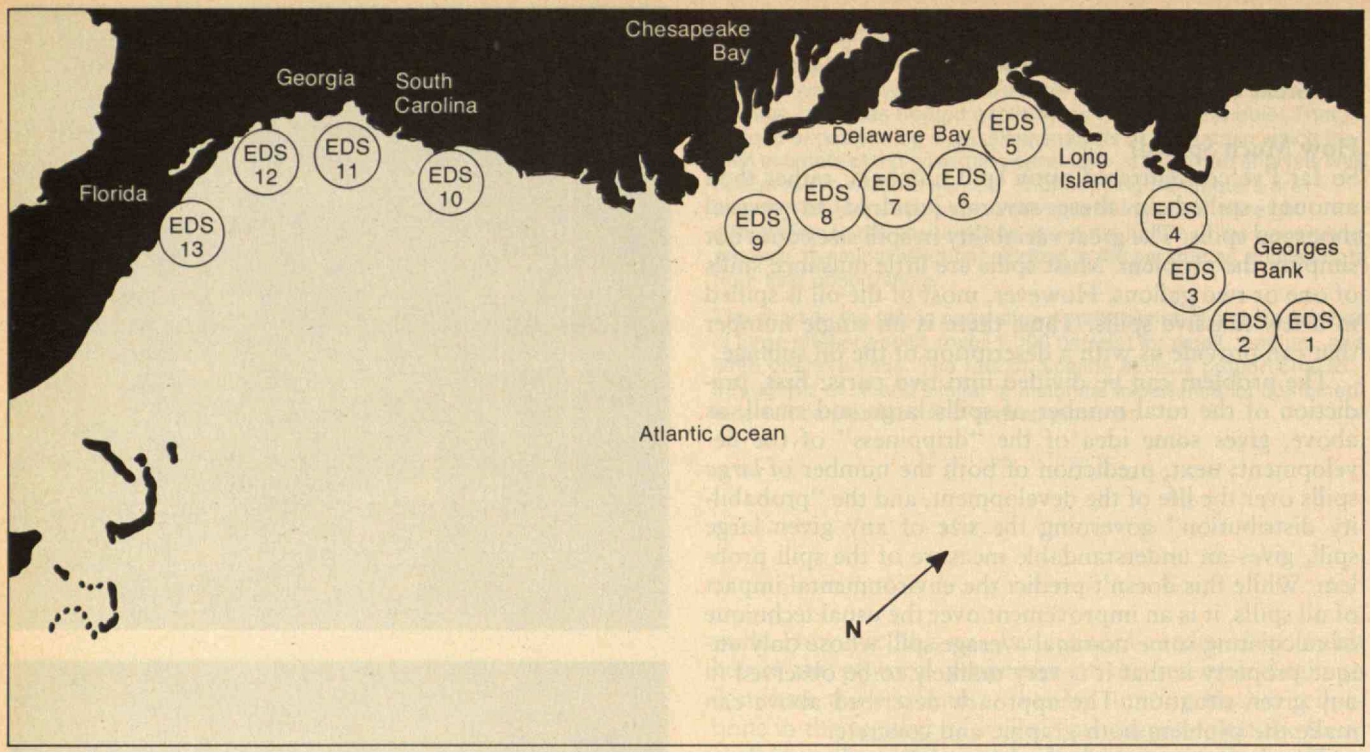
Pipeline Versus Tanker

Although it has been assumed up to this point that crude oil from an offshore development will be brought ashore by subsea pipeline, this may not follow for some of the frontier OCS regions now being let by the federal government, as these areas are hundreds or even thousands of miles from refining centers. Economic reasons suggest that the preferred form of transport from these regions will be tankers, which would load at single-buoy moor-









ings (SBMs) located in the vicinity of the field. Thus, the spillage that might have occurred from a pipeline would be replaced by that spillage which would occur at the SBM site and along the tanker route.

But the central question is the net effect of an offshore development, so tanker spillage once the tanker is moving along routes characteristic of the flow of extraregional or imported crude oil seems irrelevant. At this point the source of the crude would make no discernable difference in the incidence of oil spills. Furthermore, we've found that if a ship accidentally spills oil, the spill almost invariably occurs within fifty miles of its point of origin or destination. The principal exceptions to this rule are the spills that resulted from the explosion of Very Large Crude Carriers — "superships" — while in ballast on their return voyage, and this problem is probably now solved by keeping the empty tanks free of oxygen.

Thus, we can focus our attention on the SBM site as the location of the marginal spillage associated with tanker transport of offshore crude oil. (The same argument applied to the pipeline transport system suggests that some number should be subtracted from earlier predictions to account for reduced tanker spillage at the receiver terminal.)

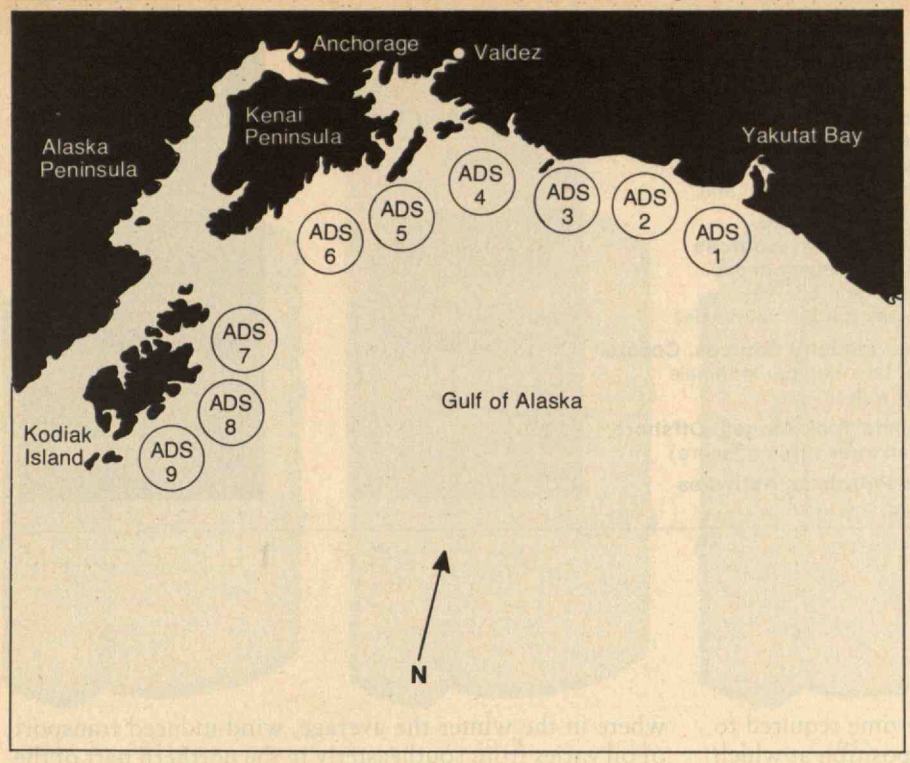
Unfortunately, data on SBM spillage are insufficient to perform the type of analysis described above for the offshore platform and pipeline. There are currently no SBM terminals in the U.S., so the Coast Guard and U.S.G.S. spill reporting systems are of no use. The only data available are from such foreign operations as the SBMs in Durban, South Africa, and Bantry Bay, Ireland. However, personal observation has contributed to substantial reservations about their quality. For instance, one of my colleagues, upon visiting the Bantry Bay facility, observed a spill that must have been several hundred gallons; it was reported as one gallon by the operator. However, the data do seem rather consistent and may well provide some useful insights into the SBM spillage characteristics.

The sizes of the SBM spills in our data are comparable to the platform spills listed on page 58, the largest SBM spill being about one million gallons, and the next largest being 100,000 gallons. The typical SBM spill apparently results from overfilling a tank or the parting of the hose from the SBM to the ship. The largest spills occur when such a failure is not detected, and pumping continues. Thus, close supervision of the loading operation could greatly reduce the amount of oil released, given a mishap. However, larger spills could occur if a fire broke out or if the ship were rammed while moored at the SBM. Neither of these is accounted for in our data, but both are possible, as evidenced by the recent collision of a tanker with an offshore platform in the Gulf of Mexico.

The data also show that the incidence of spills is higher for SBMs than for modern fixed-berth facilities, such as the port of Milford Haven, United Kingdom. At their worst, SBMs have experienced one spill per five ship calls, but a more typical value might be one spill per 30 ship calls. In Milford Haven — a fixed berth facility — the comparable rate is typically one spill per 60 ship calls. In New England in 1971-72 only one spill per 80 vessel calls occurred, including all tanker and tank barge traffic. (There is reason to believe, however, that the figure may be as high as one spill per 20 vessel calls in some areas.) Thus, the SBM is unlikely to reduce spillage and it may even prove to be a worse polluter than the present fixed-berth system.

Oil Spill Movement

Preliminary estimates of oil spill movement, given a spill location and season, can help determine the possible impact of an offshore petroleum development on adjacent coastal areas. However, these estimates are not without their uncertainties. We still do not understand how the waves passing underneath an oil slick, the wind blowing over it, and the gross motions of the underlying water



The Eastern Drilling Sites (EDS) and Alaskan Drilling Sites (ADS) considered in the study of offshore oil impacts for the Council on Environmental Quality.

combine to move oil on the surface of the sea. In fact, we still do not understand the motions of water at the air-sea interface in the absence of oil, although progress is constantly being made.

Some ignorance about oil spills is attributable to the novelty of our concern about oil spillage on the seas. Not until the *Torrey Canyon* disaster in 1967 did oil spills become a matter of serious concern to the world at large. This large oil tanker ran aground off England in March, 1967, and for three months leaked oil into the sea, causing tragic environmental damage along the French and English coasts. Since then only about 20 tests involving the planned release of oil offshore have been conducted, mostly devoted to solving operational problems such as the remote detection of spilled oil.

Limited studies of oil trajectories under laboratory and actual spill conditions indicate that oil on the surface tends to move at a velocity approximately equal to the vectorial sum of three to four per cent of the surface wind velocity, plus the residual current velocity — that portion of the current that would exist in the absence of the immediate surface wind. At M.I.T., we have developed a computer model based on this vectorial sum to simulate spill movements. Because oil spills are relatively long-lived phenomena, we also found it necessary to include measures of the variability of the wind as determined from weather data taken near spill points.

We used this computer program to "track" at three-hour intervals simulated spills released in various offshore areas. To generate a statistically representative sample, 200 hypothetical oil spills were considered at each launch point. Each spill was subjected to a statistically independent simulation of the wind field and "tracked" for 150 days. The program remembers where the spill is, and upon crossing a shoreline, the simulation is stopped, impact data pertaining to location and time is tabulated, and the next independent simulation is initiated.

The result of any one such computation would be a wiggly line representing one possible spill trajectory consistent with the residual current hypothesis and the wind statistics. The result of combining a number of such independent realizations is an estimate of the probability of an oil spill from a given offshore area impacting the shoreline. Since the wind field changes with the season, it is usually necessary to consider simulations for all four seasons.

The time factor is also vital, because natural processes, given sufficient time, tend to mitigate the effects of a spill on a beach. Lighter oil fractions evaporate into the atmosphere and turbulence breaks large oil slicks into smaller patches.

Unfortunately, little can be said about these processes in a given spill without knowing the volume of oil spilled, the rate of release, and the physical properties of the oil. All three of these parameters of a spill can vary widely:
— As noted earlier, spill volumes can vary widely;
— The rate of release can vary from the near-instantaneous rupture of a tanker to the steady release of oil from a subsea geological structural fault;
— Oil composition can range from crudes approaching gasoline to crudes very nearly like asphalt. Some very light crudes may volatilize completely within a few days to several weeks, while the heavier crudes may remain intact over very long periods in the sea.

In general, weathering processes ameliorate the onshore impact of oil spills which take a long time to reach shore.

The map *(page 50)* shows a typical output from one such study. It depicts the contours of equal probability of impacting Long Island for spill incident locations lying to the south and east of Long Island. The season is summer, and Long Island could be impacted with high probability from a region lying 10 to 20 miles to the southeast from the eastern portion of the island. Even spill sites as far east as Nantucket Shoals would appear to have some chance (less than .05) of impacting Long Island. The other map

Accidental oil spills for the years 1971 and 1972 show a remarkable consistency in the number of spills from year to year, and just as remarkable a lack of consistency in the total number of gallons spilled. This is because of the enormous size range of oil spills; one huge spill can overshadow the statistics for a given year. "Petroleum Industry" as used here means any production, refining, transport or transport-related storage of crude oil or its products, but does not include final users. For instance, a spill at a power plant would not be counted in the petroleum industry category unless it was occasioned by the transfer of oil from a barge or tanker.

Location and type at source	1971 Number of spills	1971 Volume (gals.)	1972 Number of spills	1972 Volume (gals.)
All U.S. Sources (Ships and barges of all kinds, terminals, pipelines, etc., located in inland, coastal and offshore waters)	7,462	8,618,173	8,287	21,731,755
Petroleum Industry Sources (A subset of category above; both coastal and offshore tankers, tank barges, terminals)	4,023	6,322,459	4,078	5,934,478
Petroleum Industry Sources, Coastal (Tankers, tank barges, terminals in coastal waters)	1,475	5,283,915	1,632	2,296,828
Tankers and Tank Barges, Offshore (More than three miles offshore)	22	16,315	32	2,168,811
Offshore Petroleum Activities	2,452	655,117	2,252	239,515

on page 50 shows the estimated average time required to reach Long Island beaches based on the position at which the spill occurred. Since far less than 200 samples hit shore from the more remote locations, this is not a very good estimate of the mean, but it is some indication of the characteristic times we should be considering.

We have also attempted to estimate the likelihood of spills impacting land from a number of the OCS sites in the process of being leased by the Bureau of Land Management (*see maps on pages 54, 55*). This study was conducted for the President's Council on Environmental Quality under the direction of Professor John W. Devanney. The areas investigated included the U.S. East Coast (the Georges Bank region, the Mid-Atlantic, and the coastal region of South Carolina, Georgia and Florida), and the Gulf of Alaska.

New England Spills

In general the spill trajectory behavior was highly seasonal on the east coast due to the pronounced change in the surface wind patterns between winter and summer. This is most evident in New England where winter weather is dominated by the "Montreal Express," the cold northwesterly blast of Arctic air that frequently chills the region, while summer weather is characterized by the strong Bermuda high-pressure center that brings up the humid, tropical air masses that occasionally beset even Boston.

In the winter, this wind pattern can be counted on to drive oil spills from the Georges Bank region well out into the Atlantic where they can be carried away by the Gulf Stream. In the summer, it appears probable that some spills from Georges Bank might impact on the southern New England coast. This is a result of the southwesterly surface wind and the weak current that apparently runs from northeast to southwest along our coast. (The direct evidence of such a current is patchy at best, but it is difficult to explain the observed strandings of drift bottles and cards without resorting to such a hypothesis.)

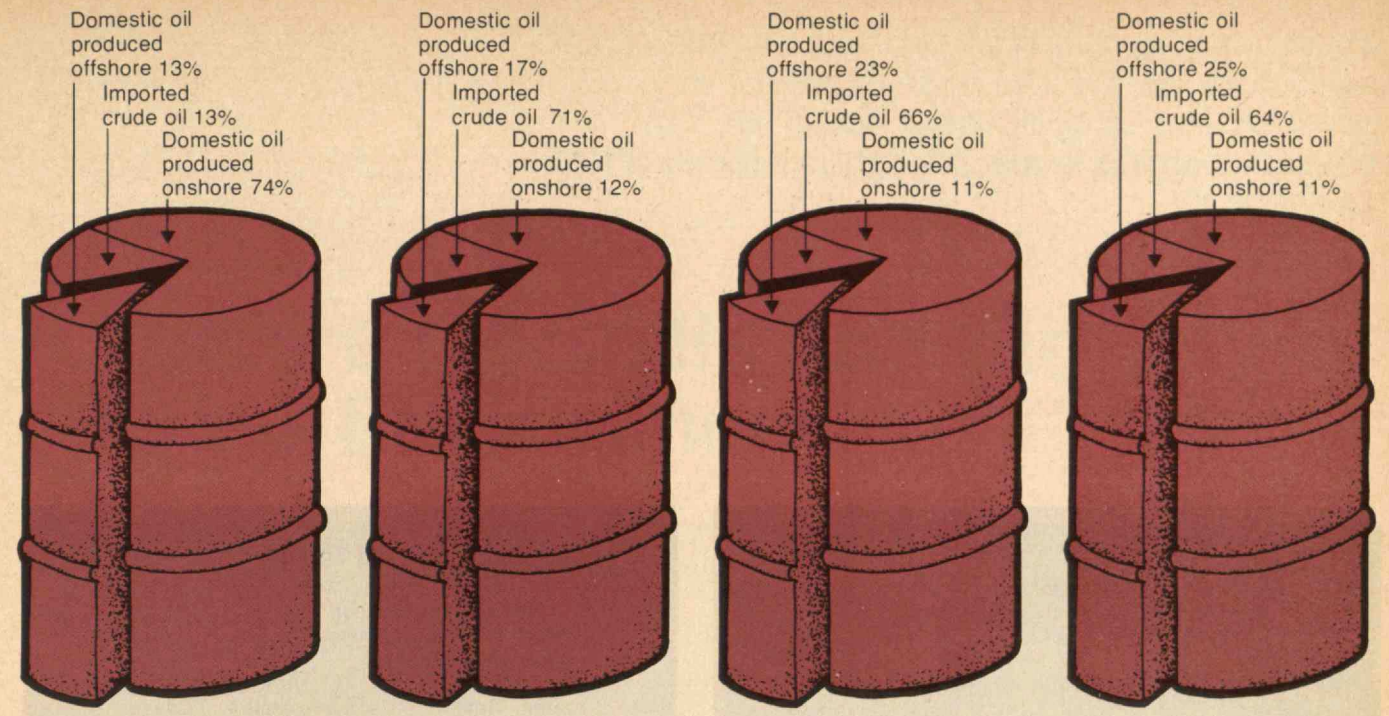
Mid-Atlantic Spills

The wind pattern is similar in the mid-Atlantic region, where in the winter the average, wind-induced transport of oil varies from southeasterly in the northern part of the region (off Long Island and New Jersey) to nearly easterly off the Chesapeake Bay. In the summer, the Bermuda high again dominates, with the average wind-induced transport being northeast. As a result, we found that in winter there were few regions except those very close to shore that had a strong chance of being the source of a spill that would impact shore. However in the summer, it appeared likely that spills released within 40 or 50 miles of Long Island had a reasonable chance of striking land — say 0.5 or so — while spills released from sites off the Chesapeake had little chance of hitting shore. Between the Chesapeake Bay and Long Island, the site of the present government leasing activities, spills launched within 80 miles of shore appeared to have some probability of hitting land — 0.2 or so — while those farther out were most likely to be transported into the vicinity of the Gulf Stream where they would be swept away from the region.

The analysis performed for the southern coastal regions indicated that the hypothesized drilling sites were all regions of high probability that a spill would hit shore for all seasons except winter, where the probability dropped to about 0.1 or so. This was in part a consequence of the proximity of the drilling sites to land; most were within 30 miles of the nearest land.

Gulf of Alaska Spills

The Gulf of Alaska also exhibited strong seasonal dependency. Here, however, there is no equivalent of the Gulf Stream to sweep spills away from land. Rather the Alaska Current appears to run counterclockwise, parallel to the coast for a distance of perhaps 100 or 200 miles from the shore. Farther offshore, the currents are dominated by the Subarctic Current which flows from west to east, diverging north and south as it nears the coast of British Columbia. The average winds are offshore except in the spring and summer when a diurnal sea breeze is established that persists from late morning well into the afternoon along most of the southeastern coast. This breeze contributes a net motion to the north, or onshore. However, even in the fall and winter the variability is so great



Total U.S. consumption (million barrels)

Offshore oil has typically constituted only about ten per cent of the U.S. consumption of crude oil. . . .

Region	Crude oil source	1971-1972 Average annual throughput (million barrels)	Spillage 1971 Spills	Spillage 1971 Gals.	Spillage 1972 Spills	Spillage 1972 Gals.	Spillage/million barrels throughput 1971 Spills	Spillage/million barrels throughput 1971 Gals.	Spillage/million barrels throughput 1972 Spills	Spillage/million barrels throughput 1972 Gals.
New England	Shipped from foreign and extra-regional sources (bulk of crude shipped to Canada via pipeline with terminal in Portland, Me.)	182	26	3,194	25	3,625	.143	17.5	.142	19.9
Mid-Atlantic (north of Virginia)	Shipped from foreign and extra-regional sources (crude supplier regional refineries)	450	8	9,495	45	118,109	.017	21.1	.10	262.4
Gulf of Mexico and Southern California	All offshore production of crude oil (crude transported to shore via subsea pipeline)	615	2,452	655,117	2,252	239,515	3.986	1065.2	3.66	389.45

. . . but as this table shows, it has accounted for far more spillage per barrel of crude oil produced than is experienced in the importation of crude oil in areas such as New England and the mid-Atlantic.

There are some minor qualifications to this statement. The number and volume of spills associated with the importation of crude may be slightly understated. Specifically, spills of bunker or lubricating required for crude carrier operation are omitted. However, all crude oil spills are included, so we can be sure that we are getting the bulk of the spills, since crude is the product most handled and most exposed to spillage. Also, the small number of spills reported for the mid-Atlantic region in 1971 could well indicate a laxity in the reporting system, since it was in its first full year of operation.

Spills over 1,000 barrels from OCS platforms

Date	Offshore lease location (Gulf of Mexico, unless otherwise indicated) Area, Block No.	Amount (gals.)	Cause
4-8-64	Eugene Island, 208	107,478	Collision
10-3-64	Ship Shoal, 198	66,738	Hurricane
10-3-64	Eugene Island, 208	217,560	Hurricane
10-3-64	Ship Shoal, 149	214,200	Hurricane
7-19-65	Ship Shoal, 29	70,896	Blow out
1-28-69	Santa Barbara Channel (Cal.)	991,620	Blow out
3-16-69	Ship Shoal, 72	105,000	Blow out
8-17-69	Main Pass, 41	512,000	Storm
2-10-70	Main Pass, 41	1,281,000	Fire
12-1-70	South Timbalier, 26	2,226,000	Explosion, fire
1-9-73	West Delta, 79	417,270	Structural failure
7-20-72	Platform 15 miles offshore	168,000	

Spills over 1,000 barrels from pipelines in OCS and coastal region 1964-74

Date	Offshore lease location (Gulf of Mexico, unless otherwise indicated) Area, Block No.	Amount (gals.)	Cause
10-15-67	West Delta, 73	6,746,838	Anchor dragging
3-12-68	South Timbalier, 131	252,000	Anchor dragging
2-11-69	Main Pass, 299	316,344	Leak
5-12-73	West Delta, 73	210,000	Leak corrosion
8-2-73	Avco "C" South Pass, 60	43,000	Leak
4-17-74	Eugene Island, 317	832,986	Anchor dragging
9-9-74	Main Pass, 73	92,946	Hurricane
10-18-70	Louisiana Coastal Channel	1,050,000	Tug propeller
3-17-71	Louisana Coastal Channel	154,980	Leak
9-28-71	Louisana Coastal Channel	43,000	Pipe parted
11-30-71	Texas Coastal Channel	43,000	Leak
12-12-72	Louisiana Coastal Channel	160,000	Equipment failure

The data for the predictions of the possibilities of large oil spills from offshore platforms and pipelines. Sources: U.S. Coast Guard, U.S. Geological Survey.

that the wind-induced dispersion occasionally overwhelms whatever net offshore motion there may be. Spills occurring off Kodiak Island appeared to have little chance of beaching except in the summer season. Over the rest of the Gulf of Alaska the chance of beaching was reasonably high in all seasons, although spring and summer exhibited probabilities of impact close to unity, or about twice that of the winter and fall.

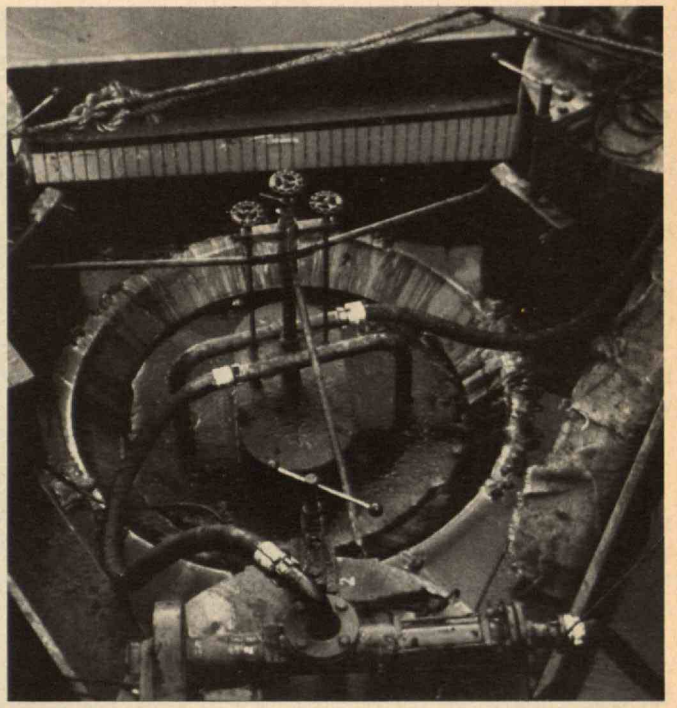
The average time to shore also varied by region. In the Gulf of Alaska, these times were typically weeks, whereas for the other regions studied the value was typically one or more months, with the exception of the region lying just south of Long Island, where the time was about a week or so.

Spills and the Future

Offshore oil production as now practiced in the Gulf of Mexico contributes a relatively small portion to the total U.S. spillage figure. If we were to consider all sources of oil pollution, the percentage would be smaller yet. However, if future developments have the same sort of spillage per barrel of production, and if they should ever begin to account for a more substantial fraction of the total U.S. demand for crude oil, then it is a matter of arithmetic to determine their potential as a major source of accidentally spilled oil within the U.S.

Compared to the alternative of increased imports, offshore oil appears to be a messier means of acquiring crude oil, although offshore oil proponents have not attempted to sell it on the basis of its environmental advantages. On the other hand, most spills seem to come from older fields, and this may be due to some age-related process. Under today's economic conditions, fields will probably be developed, produced and abandoned much more rapidly than in the past. This might short-circuit the aging problem. Modern technological developments, although not aimed primarily at reducing spills, may coincidentally provide superior spill prevention performance. However, the improvement may not be detected until today's construction enters its declining years.

Also significant and often neglected is that future offshore oil developments will introduce oil spillage to regions currently relatively free of this form of pollution. We should not accept unproven the assertion that because



A vacuum barge takes on oil from a skimmer as an oil spill in a New England harbor is cleaned up. (Photos courtesy of Coastal Services, Inc., Braintree, Mass.)

one region can apparently withstand the stress of oil pollution, others can too. For example, New England had 1,250,494 gallons of crude oil and petroleum products spilled upon her waters from industry-related sources in 1971 to 72, primarily in coastal waters. If we had transplanted the entire Gulf of Mexico offshore production operation into the Gulf of Maine on January 1, 1971, this figure would have jumped to a total of 2,084,448 gallons, with the bulk of the increase being spilled in waters that are presently unpolluted by oil.

Suggested Readings

Accidents Connected with Federal Oil and Gas Operations on the Outer Continental Shelf (statistics to January, 1975), Geological Survey, U.S. Department of the Interior, January, 1975.

J. W. Devanney III, R. J. Stewart, et al., *Primary Physical Impacts of Offshore Petroleum Developments*, M.I.T. report no. MITSG-74-20, prepared for the Council on Environmental Quality, April, 1974.

Don E. Kash, et al., *Energy Under the Oceans*, Norman, Oklahoma, University of Oklahoma Press, 1973, 375 p.

Outer Continental Shelf Statistics (statistics for 1953 through 1974), Geological Survey, U.S. Department of the Interior, June, 1975.

Petroleum Systems Reliability Analysis, Computer Sciences Corp., report to the Environmental Protection Agency under contract no. 68-01-0121, February, 1973.

R. J. Stewart and J. W. Devanney III, *Probabilistic Trajectory Assessments for Offshore Oil Spills Impacting Long Island*, M.I.T. Department of Ocean Engineering report to Regional Marine Resources Board, Nassau-Suffolk Planning Board, Hauppauge, N.Y., November, 1974.

The Georges Bank Petroleum Study, Offshore Oil Task Group, M.I.T. report no. MITSG-73-5, February, 1973.

Robert J. Stewart is currently completing his Ph.D. dissertation in the Department of Ocean Engineering at M.I.T. He received his B.S. in engineering from Harvey Mudd College in 1967, and his S.M. in ocean engineering from M.I.T. in 1973. He served as a commissioned officer in the Coast Guard from 1969 through 1971 and has consulted with several private companies and a number of government organizations in the areas of oil spill impact and petroleum production technology.

Marine ecology is so complex and our knowledge so meager that we can hope to predict only generally how oil spills affect ocean life. But perhaps learning to ask the right questions is just as important.

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Department of Civil Engineering
M.I.T.

Offshore Oil Spills and the Marine Environment

Elsewhere in this issue Robert Stewart has dealt with the large uncertainties surrounding the likelihood of oil spills from offshore oil operations. Unfortunately, similar extreme uncertainties hinder our understanding of the impact of oil spills on ecosystems. As a result, we have found that predicting such impacts in absolute terms is quite unrealistic. So, in our studies of oil spills and marine ecosystems for the Council on Environmental Quality (C.E.Q.), we undertook to lay out as well as possible differences that may affect a region's ecological vulnerability to oil spills.

There are two phases in the effects of an oil spill on the environment. First come the *initial impacts* of a spill, which are the actual perturbations of an area's physical/chemical and biological features. Then follows the *recovery period,* which is the return to pre-spill conditions following intitial impacts *(see page 62)*. This recovery doesn't just include biological recovery, but also physical/chemical recovery of the water, sediments, etc.

The Initial Impact

How profound the initial impact of an oil spill will be depends both on the nature of the community of animals and plants in an area, and the nature of the oil.

By the nature of the animals and plants, I mean the sensitivity of an individual species to the oil, and the life history of the species — how long it lives, how it breeds and grows and where it migrates. The relationship of the organism to the community is also important; for instance, we must know what other creatures it competes with and what creatures prey on it. There is really very little understanding about overall community dynamics of an ecological system subjected to such disturbances as oil spills. So, we have limited ourselves to noting particular relationships between certain species that we know or believe play an important role in recovery.

The nature of the oil has to do with:

— Oil composition. The relative and absolute amounts of various hydrocarbon fractions. We are most interested in the concentration of lower boiling (less than 250°C.) aromatic hydrocarbons, because they are most likely to damage organisms.

— Oil amount. Actual volume of oil impacting an area; thickness and size of slicks, patches, etc.

— Geographical degree of coverage. The percentage of area covered with oil and distribution of oil coating within the area of interest.

— Meteorologic/oceanographic conditions. Sea conditions such as waves, surf, etc., which determine how extensively oil is mixed in the water column and into sediments.

Given the large biological uncertainties, it is not worthwhile at present to describe the nature of any hypothetical spill in terms of the specific factors I've mentioned. But it is useful to describe a spill in more general terms, such as weathered/unweathered, to determine ecological impacts. So, here are the general assumptions we have chosen to go by:

— Unweathered crude oil contains sufficient low boiling toxic fractions to kill most marine organisms exposed to the slick.

— Coating by the main body of a slick or by patches of weathered oil will likely kill most sessile (permanently anchored) species and alter any sediments, rocks, etc.

— Sublethal effects from accidental spills cannot be accounted for in most situations.

— Hydrocarbons are likely to be incorporated by most species, especially filter feeders such as clams, when they are exposed to all but residual fractions. Whether or not the organisms will take in tarry, residual substances is unknown.

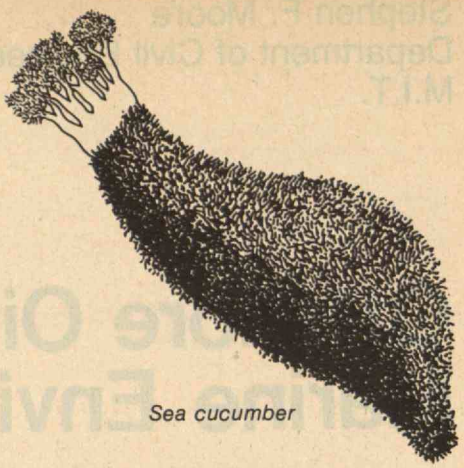
These factors determine how much of a population within a habitat or region is killed or otherwise affected by a spill.

It is virtually impossible to predict the impact of an oil spill when it affects a system only partially. For instance, we would have to account, not only for population reduction, but the complex changes in the age structure of a population. For the most part, then, we have confined our analysis to the worst possible case — where 100 per cent of organisms exposed are killed. With uncertainties aside, this is a useful way to approach the problem.

Recovery from a Spill

Recovery from oil spills, although difficult to define, consists generally of degradation and natural removal of oil from exposed areas followed by return of populations and communities.

How long oil remains in various habitats depends on evaporation, dissolution, microbial oxidation and chemical photo-oxidation. While we know that degradation by microbes and chemical processes depends on the available nutrients, light, temperature, substrate particle size and water velocities, we aren't sure of the relationships among these variables. Therefore, we estimate the persistence of oil in habitats by empirically inferring from data for specific spills including: West Falmouth, Mass., in 1969; Santa Barbara, Calif., in 1969; tanker *Arrow* in



Sea cucumber

Chedabucto Bay, Nova Scotia, in 1970; San Francisco Bay, Calif., in 1971; and *Torrey Canyon* off the coast of southwest England, in 1967.

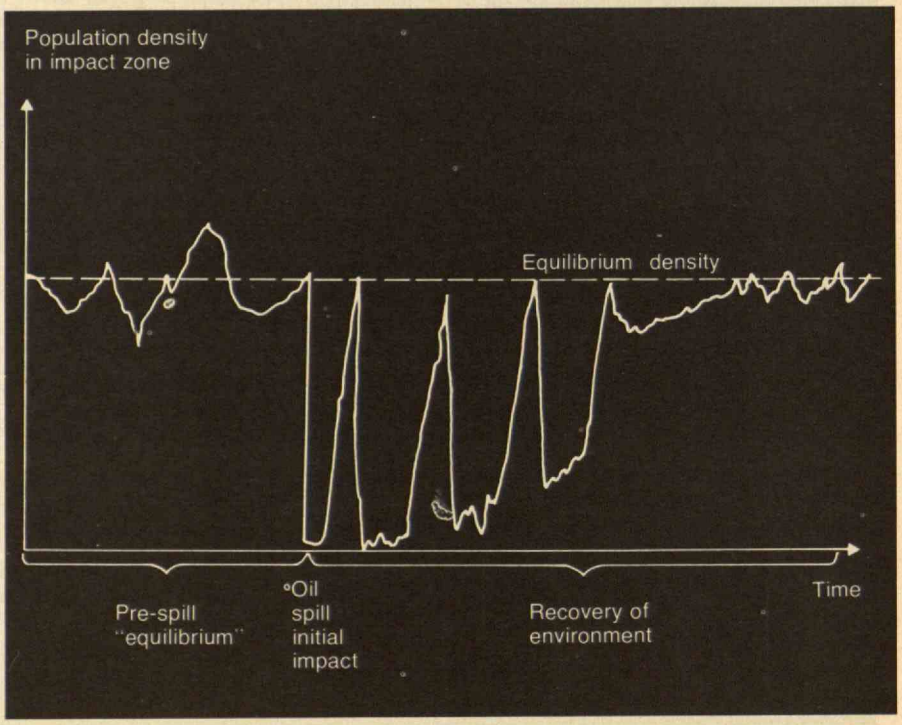
Our inferences of the persistence of oil in different habitats are summarized on page 67. But take care in interpreting this graph, because many times the persistence figures from a study depend more on the length of study than on the actual time oil remains in a habitat. In many cases the investigators stopped collecting data before the oil was no longer visually or analytically detectable. Thus, the wide variation of estimates; for instance Rocky Shore's minimum weathered oil time (greater than five months to at least three years) is chiefly attributable to the length of investigation, not to differences in persistence time of oil. Therefore, you should consider these figures as *minimum residual times of oil*; they are meant to give a "feel" for the duration of petroleum persistence in a habitat, rather than to constitute hard measurements.

The results aren't definitive, but they do allow us to make some differentiation among habitats. In general, oil deposited in unconsolidated, fine sediments can remain chemically and/or physically insulting to the environment for four to ten years. In rocky substrates, oil may be removed naturally in as little as two years. We believe that the persistence of oil in marine habitats varies from region to region primarily with temperature and sunlight — for instance, oil spilled in northerly habitats may persist for longer periods than in southerly habitats. However, the data that we have do not tell us how large these region-to-region differences are.

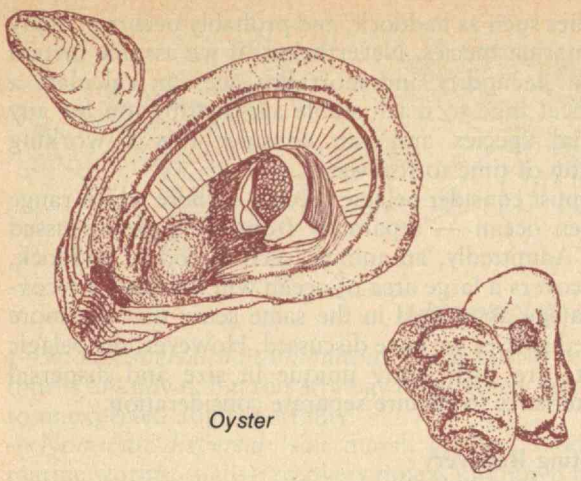
Biological Recovery from a Spill

If physical/chemical recovery is measurable, biological recovery is certainly not, and the multitude of factors involved make it highly subjective. We define biological recovery in the case of 100 per cent mortality as the return to a specified density and stable age distribution — assuming, of course, that the habitat has already physically and chemically recovered.

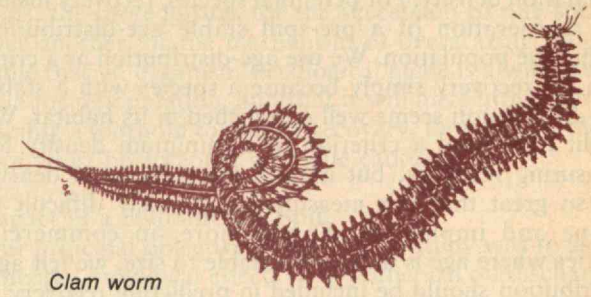
To predict population density and age distribution we must also examine the normalcy of such species characteristics as fecundity and survivorship and such relationships among species as competition and predation. Much of this is unknown. However, with the data available, we can divide marine organisms into general *recovery strategy classes* — classes with sufficiently broad bounds that even a sketchy description of a species' characteristics will suggest its class of recovery strategy.



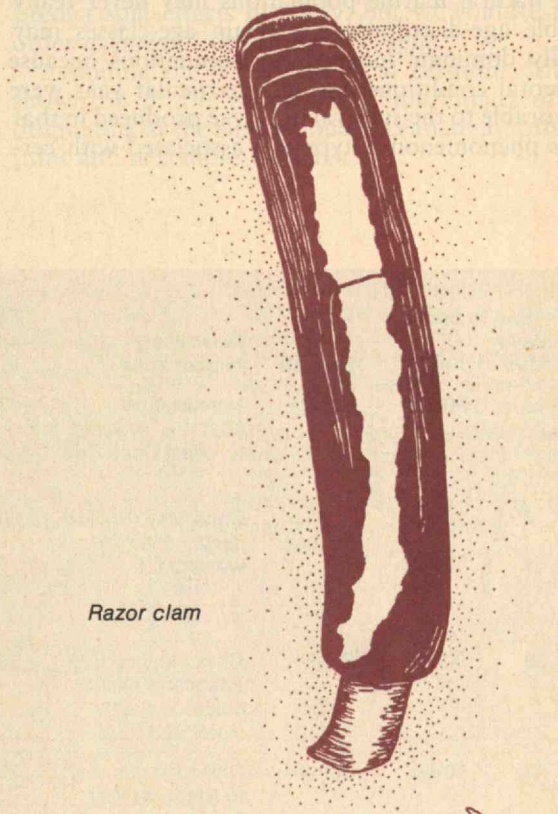
The impact of a severe oil spill on the marine environment is usually rapid and pronounced, followed by a slow recovery of the waters, sediments, and sea life.



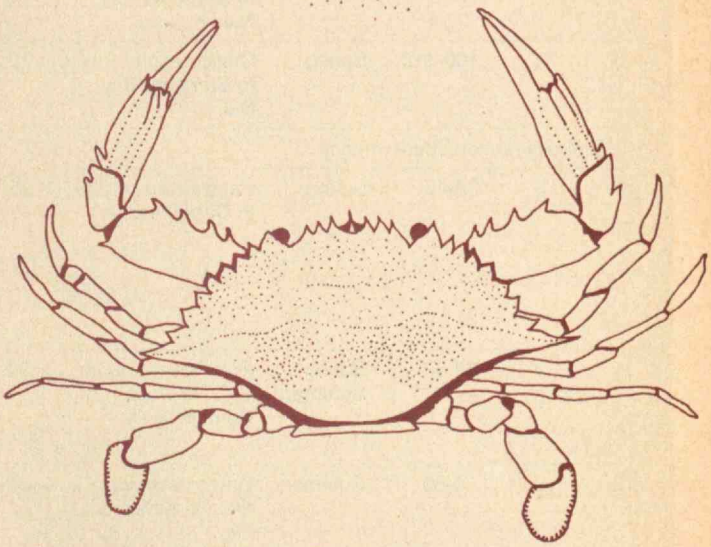
Oyster



Clam worm



Razor clam



Drawings on pages 62 and 63 from A Handbook for Beach Strollers *by Donald J. Zinn, University of Rhode Island Marine Advisory Service; on pages 65 and 66 from the Massachusetts Audubon Society.*

What follows is the general event-schedule of recovery from an oil spill, with explanations of the classes of recovery strategy.

— *Recovery begins with survivors.* Some fraction of the original population, or perhaps none, within boundaries of interest survives the spill.

— *Colonizers enter recovery area.* Immigrants, usually larvae or other new-born, disperse into and within the habitat. There are two classes of dispersal — *wide* and *non-wide.* Wide-dispersal species, such as barnacles and mussels on the rocky shores, are those which can reinvade all parts of their pre-spill habitat with equal ease. Only the time-to-recovery need be predicted and spatial recovery can be assumed to be uniform. The majority of marine animals fall into this category. Non-wide dispersal or incremental growth species are those which cannot colonize the entire areas of a habitat in a single reproductive season. These include salt marsh grasses, beach fleas, and certain species of worms and snails. One can imagine that the range of a non-wide-dispersal species will expand incrementally, "creeping" outward from a pocket of survivors or inward from the edges of the spill. Obviously, then, both spatial and numerical recovery must be tracked in determining non-wide-dispersal species recovery.

We must also distinguish between wide-dispersal species in which immigrants, usually larvae, arrive a few at a time to resettle the area and species in which larvae wash in on the tides in millions. We term the latter the "ubiquitous immigrant" case and the former the "non-ubiquitous" case. Most wide-dispersal marine species have ubiquitous immigrants. Only birds qualify in our analysis as species with non-ubiquitous immigrants. The non-ubiquitous immigration may be due to a shortage of settlers, or to unfavorable winds or tides. This category is difficult to analyze due to the uncertainty of immigrant availability.

— *Colonizing individuals settle.* A third phase of recovery begins after oil has degraded sufficiently to allow successful settlement, and colonizers are exposed to the usual physical rigors of the habitat — temperature, salinity, waves. However, these may be altered significantly in the wake of the spill; for instance, loss of marsh grasses may permit wave-induced erosion. Plants and animals also suffer biological pressures which change continuously with recovery. Predation, parasitism, competition and commensalism during recovery may differ dramatically in intensity and identity from these processes before the spill. This succession of marine habitats is one that has

not been explored, and deserves attention.

— *Recovery is completed.* For species that undergo annual life cycles of dying off and replenishment, recovery from an oil spill is defined as re-establishment of pre-spill population density. For perennial species, recovery means the regeneration of a pre-spill stable age-distribution within the population. We use age-distribution as a criterion for recovery simply because a species with a stable age-distribution seems well entrenched in its habitat. We might have used a criterion of a minimum density for measuring recovery, but natural fluctuations in density are so great that this measure is extremely difficult to define and implement. Furthermore, in commercial species where age is directly relatable to size, we felt age-distribution should be included in predicting recovery.

In fact, natural marine populations may never really show stable age-distributions. Certain age-classes may numerically dominate longer-lived populations because environmental conditions during a particular year were highly favorable to the survival of larvae produced in that year. This phenomenon is typically associated with certain fishes such as haddock, and probably occurs in many other marine species. Nevertheless, if we assume certain levels of fecundity and mortality, we can calculate a theoretical time to reach stable age-distribution for any perennial species and can consider this a working definition of time to recovery.

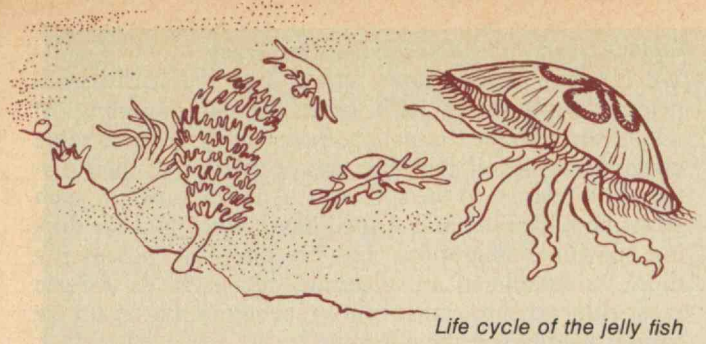
We must consider pelagic species — those which range the open ocean — separately from all these discussed above. Admittedly, an animal, such as cod or haddock, which covers a large area of ocean will not have a recovery strategy associated in the same sense that the more localized species we have discussed. However, the pelagic habitats are sufficiently unique in size and dispersal characteristics to require separate consideration.

Estimating Recovery

Based on these recovery strategies, we can now estimate the biological recovery time for each class of species:

— *Wide-dispersal-ubiquitous* (a majority of species): recovery time is estimated to be about the life span of the animal or plant.

EDS	Time to shore days Min.	Ave.	Season	Most likely impact zone	Per cent of spills ashore in zone	Oil composition	Oil amount	Coverage
4	43	90-100	Spring	Nantucket Is., Martha's Vineyard, S. coast Cape Cod	17	Very weathered	Tar balls and small patches	Uneven, widely scattered over impact zone
5	7	30-50	Spring-Summer	Cape May (S. New Jersey coast) to western L.I.	60-75	Weathered	Patches 1-100 acres in size	High energy beach, even distribution within sub-area of impact zone. Estuarine subsystem: occasional patches which are carried past barrier beaches.
6	39	90-100	Spring	Chincoteague Bay (Maryland Atlantic coast) to Sandy Hook, N.J.	39	Very weathered	Tar balls and small patches	Uneven, widely scattered over large area of impact zone
7	28	50-60	Summer	Chincoteague Bay to Barnegat Bay, N.J.	28	Very weathered	Tar balls and small patches	Uneven, widely scattered over large area of impact zone
8	73	100-110	Spring	Chincoteague Bay to Barnegat Bay, N.J.	10	Very weathered	Tar balls and small patches	Uneven, widely scattered over large area of impact zone
9	Virtually no nearshore impact							
10	5	30-40	Spring	Cape Romain, S.C., to Cape Fear, N.C.	95	Weathered	Patches 1-100 acres in size	Even distribution within sub-area of impact zone. Occasional patch may enter estuarine subsystem.
11	7	30-50	Spring-Summer	Port Royal Sound, S.C., to Cape Romain, S.C.	70-99	Weathered	Patches 1-100 acres in size	Even distribution within sub-area of impact zone, including estuarine areas.
12	19	50-60	Summer	Daytona Beach, Fla., to Savannah, Ga.	85-90	Very weathered	Patches	Widely scattered over large areas of impact zone.
13	49	70	Summer	Cape Canaveral, Fla., to St. Augustine, Fla.	100	Very weathered	Patches	Widely scattered over impact zone



Life cycle of the jelly fish

— *Wide-dispersal non-ubiquitous* (most birds): recovery time is unknown, but this strategy is extremely vulnerable to unexpected adult mortality.
— *Non-wide-dispersal* (salt marsh grasses, sand fleas, marine worms, snails): recovery time is unknown but it is at least as long as the creature's life span.
— *Pelagic species*: only those species which breed in a localized area, such as salmon, alewife, or striped bass are potentially vulnerable, but we are still unsure of the significance of any threat.

We caution that this analysis of recovery is only a first approximation and does not consider many potentially important aspects of the problem. For instance, we don't know the basis for explosive blooms of animal populations, the prerequisites for the succession of one species over another, or the mechanism of overgrazing. We assume that an organism's ecological niche is always available for repopulation, and that it will have little problem gaining a foothold to initiate recovery. Our results, therefore, must be accepted with due caution.

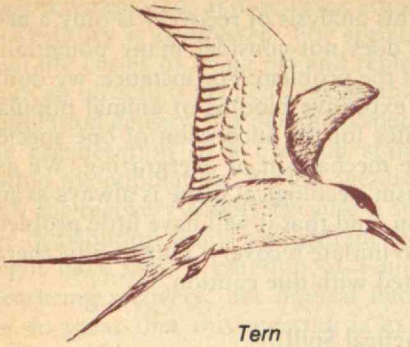
Impact of a Hypothetical Spill

Our principal objective in the C.E.Q. study was to assess potential biological effects of hypothetical oil discharges. Given the aforementioned uncertainty, we could not predict spill effects precisely, but we could estimate the order-of-magnitude impact of a spill.

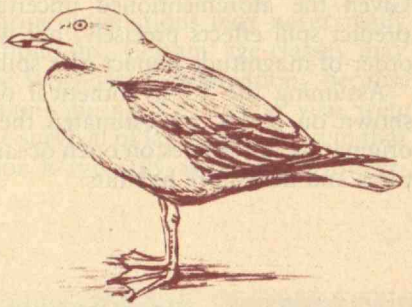
Assuming the 13 hypothetical offshore drilling sites shown on p. 54, we estimated the impact of oil spills originating at the sites on open ocean areas, offshore bottoms and nearshore habitats.

Habitats exposed to oil	Coating and habitat alteration	Residence time
Primarily sandy/rocky shores, possibly salt ponds	Intertidal, sessile species; e.g. barnacles, tide pool inhabitants, mussels, sand dollars, no plants susceptible to mortality by direct coating	3-5 yr. min.
High energy beach, may enter inlets into oligohaline, grassy bottom and migrating subsystems (estuarine subsystem)	High energy beach, little or no mortality alteration of sandy substrate where oil patches deposited. Estuarine subsystem, intertidal species susceptible to mortality, especially intertidal grasses	2-3 yr.
High energy beach	Little or no coating mortality; scattered tar balls in sandy substrates	2-3 yr.
High energy beach	Little or no coating mortality; scattered tar balls in sandy substrates	2-3 yr.
High energy beach	Little or no coating mortality; scattered tar balls in sandy substrates	2-3 yr.
High energy beach, estuarine subsystems, neutral embayment (Cape Romain)	High energy beach, little or no mortality, some alteration of sandy substrate, neutral embayment —? Estuarine subsystems, intertidal species susceptible to coating especially grasses. Cape Romain area should be given more detailed study.	2-3 yr. min.
High energy beach, estuarine subsystems, oyster reefs neutral embayment (Cape Romain)		2-3 yr. min.
Estuarine subsystems, worm and clam flats, high energy beaches	Little or no coating mortality; oil deposited on sandy and muddy substrates will cause local alteration of habitat.	2-3 yr. in high energy beach; 4-5 yr. min. in soft bottom
High energy beach	Little or no coating mortality, scattered tar balls in sand	2-3 yr.

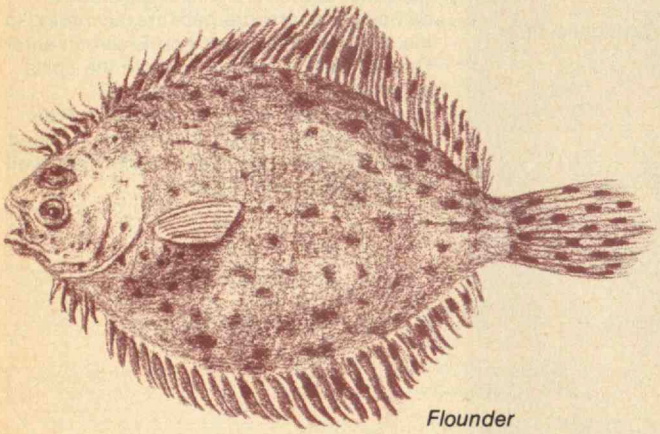
None of the hypothesized offshore spills from offshore drilling in the Atlantic is expected to cause significant biological damage to nearshore habitats, according to the study for the Council on Environmental Quality. This is mainly because the spills originate far enough offshore that weathering and dispersal alleviates their impact. Drilling sites 1-3 were not included because drilling site 4 represents them well in terms of oil spill impacts.



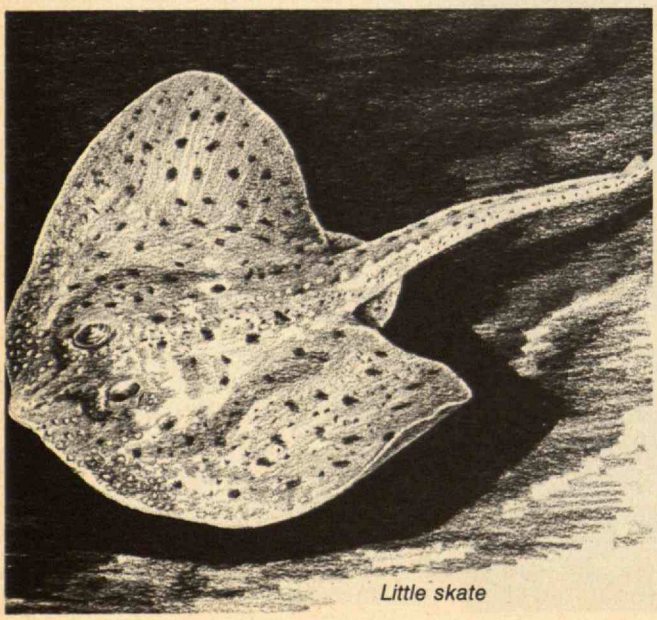
Tern



Gull



Flounder



Little skate

Open Ocean and Offshore Bottom Areas

We can hypothesize fairly safely that widely-dispersed pelagic populations with extensive intermingling of adults throughout the pelagic zone suffer no detectable effects from an oil spill, because of the size of their distribution relative to the spill area. Anadromous fish such as salmon, alewife, and striped bass, which localize during spawning migrations and breeding, are potentially more vulnerable to an uncertain degree. Birds are the most vulnerable to catastrophic mortalities, but again we cannot predict specific effects.

Offshore bottoms may be exposed to oil because of sedimentation or other processes which transport oil downward, although these processes are not well enough understood to predict the amount or composition of oil that may reach bottom sediments at various depths. When the tanker *Arrow* lost about 100,000 barrels of oil in 1970, little or no oil went below 100 meters. However, in the 1969 spill off Santa Barbara, Calif., significant amounts of oil were deposited in offshore bottom sediments because high concentrations of suspended sediment in the region carried the oil downward.

In general, crude oil transported into offshore bottom sediments has lost a large percentage of its lower-boiling, toxic hydrocarbons during the sedimentation process. And, the oil is likely to be enough dispersed so as to have no significant coating effect. More important, such bottom-deposited oil may alter sediment characteristics, possibly making affected areas unsuited for certain normally found species. Such effects may persist for two to three years in sandy bottoms, longer in sediments containing significant amounts of silt or mud, and indeterminately if sediments have little or no oxygenation to break down the oil. We can go beyond these generalizations only when we have better knowledge of the amount and composition of oil which may be transported into the sediments.

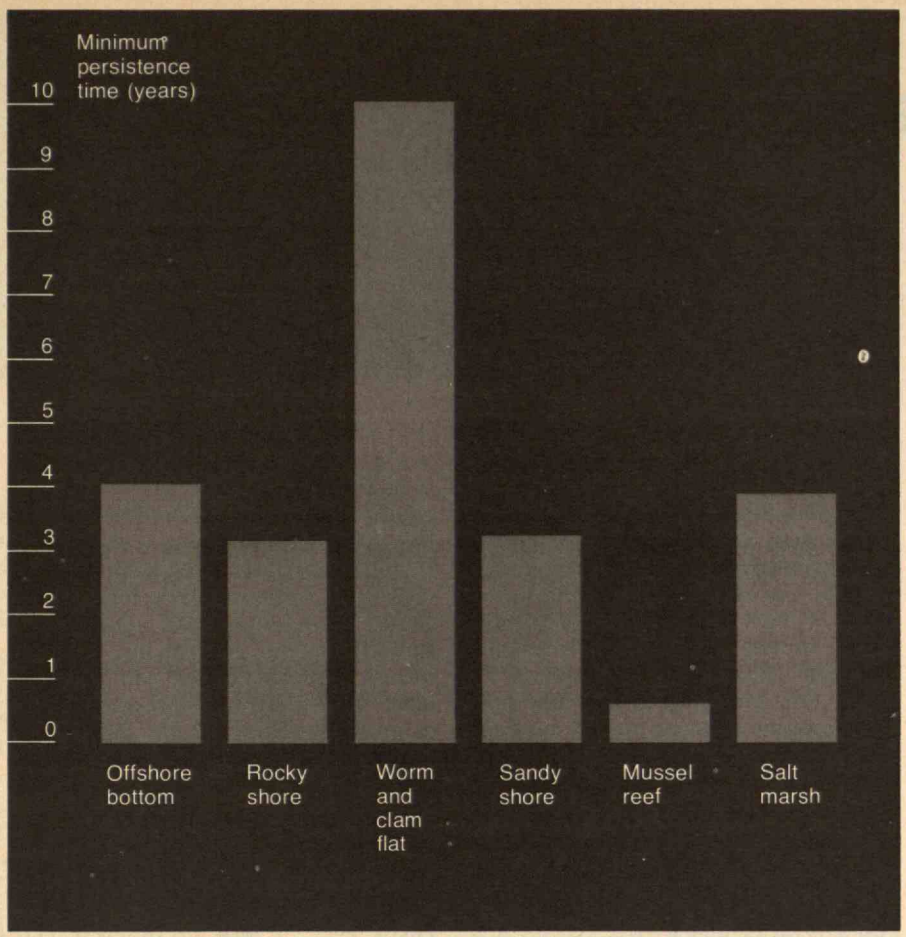
On page 64 are summarized the spills we hypothesized from the ten most critical Atlantic offshore drilling sites. Taking the spill movement data developed by Devanney, Stewart and Briggs, we estimated the biological impacts on the nearshore habitats.

According to our studies, *none of the hypothesized offshore spills is expected to cause significant biological damage to nearshore habitats.* We predict that they present no toxicity to the biological communities and immeasurably small coating and habitat alteration. This is mainly because all the spills originate far enough offshore that weathering and dispersal alleviate their impact.

We did not draw any conclusions about the effects of spills on the Alaskan coast, because data is so sparse as to make even a first estimate impossible.

The Implications of Ecological Uncertainties

Our present state of understanding does not allow a comprehensive and definitive answer to the question of biological effects of Atlantic/Alaskan offshore spills. In fact, we would caution against any apparent attempt to answer this question systematically, for it would be hiding the true nature of the situation and would be irresponsibly misleading. That is, such an analysis would imply that the problem is understood well enough to warrant an attempted answer to the question when, in fact, so many basic requisite facts are unknown that even in the best possible world there is no way of knowing the validity of the analysis.



Oil lingers for different periods in different habitats, as this graph shows. These specific numbers, however, should be taken as the minimum residence times of an oil spill, because many studies of oil spills are terminated before the oil is actually gone from the environment.

Hence, the principal objective of our analysis is to indicate what is known and what is not, and thereby show the uncertainty of the information base upon which any decision is made. By at least asking the proper questions, we can begin collecting the right data and formulating our model.

Unlike the physical systems to which most engineers are accustomed, ecological systems possess a cybernetic quality of adaptation, self-direction, and learning. Superimpose this property on a complex, non-linear, interconnected structure, and the result is a system that is inherently uncertain, shifting, adjusting, accomodating to sustain itself in the face of unexpected fluctuations. Our experience in this study convinces us that our present understanding of these phenomena is meager and our available mathematical models are inadequate to describe and analyze them. More data will not necessarily alleviate the problem. Furthermore, as economist Kenneth Boulding has suggested, mathematical models often provide the illusions of certainty which can be an important source of bad decisions.

To make these environmental decisions in an environmentally and economically acceptable way, we advocate a closer cooperation among decision-makers, modelers, and monitors. And, this interaction must be adaptive and reconsidering, so that if new data indicates undesirable outcomes of a decision, it will immediately be reassessed and adapted to fit our improved knowledge. Implied here is that positive decisions can be made, but that large-scale developments which cannot be readily revised given new environmental information are avoided. Furthermore, monitoring becomes essential not just for regulation and enforcement, but as an integral part of an on-going, adaptive decision-making process, which is as flexible as the ecological system of which it is a part.

Suggested Readings

S. F. Moore and R. L. Dwyer, "Effects of Oil on Marine Organisms : A Critical Assessment of Published Data," *Water Research* 8:819-827, 1974.

S. F. Moore, G. R. Chirlin, C. J. Puccia, B. P. Schrader, *Potential Biological Effects of Hypothetical Oil Discharges in the Atlantic Coast and Gulf of Alaska,* M.I.T. Department of Civil Engineering Report to the Council on Environmental Quality, M.I.T. Sea Grant Report #MITSG 74-19, 1974.

D. S. Stewart, J. W. Devanney, W. Briggs, *Oil Spill Trajectory Studies for the Atlantic Coast and Gulf of Alaska,* M.I.T. Department of Ocean Engineering, Report to Council on Environmental Quality, 1974.

Stephen F. Moore is an associate professor in the Department of Civil Engineering at M.I.T. He received his M.S. and Ph.D. degrees in civil and environmental engineering from the University of California, Davis. His research has focused on ecological systems analysis and design and management of environmental monitoring programs. Prior to the C.E.O. study he conducted research on environmental impacts of oil supertanker ports and offshore oil exploration on the Georges Bank. He has participated in two panels of the National Academy of Sciences and is a consultant to several private corporations. He is currently a member of UNESCO's Interdisciplinary Working Group on Environmental Aspects of Engineering Education and Training.

How to Pack a Box of Boxes

Puzzle Corner
by
Allan J. Gottlieb

I often receive inquiries about why a response appears in the "Better Late Than Never" category when the writer believes it was submitted "on time." The answer is that my column is sent to the Editors *two months* before you read it. For example, today is December 1, and my deadline for the February issue is December 10; thus, nothing received after about December 8 could be included in this issue.

Continuing the policy started in December, I now present a problem which appeared previously but was not completely solved. But let me correct an error in the January issue: NS 1 first appeared in the April, 1966, issue of *Tech Engineering News*, the M.I.T. undergraduate engineering magazine; it reappeared in *Technology Review* in November, 1966. "Puzzle Corner" began in *Tech Engineering News* during my junior year at M.I.T. (1965-66) and was picked up by *Technology Review* the year after. Unfortunately, I have no record of the first year's columns. If any reader has back issues of *Tech Engineering News*, I would greatly appreciate copies of my first months' attempts at journalism.

Problems

NS 2 This month's "not-previously solved" offering appeared in February, 1967, in *Tech Engineering News* and *Technology Review* (the column was then syndicated); it was submitted by Nicholas J. Pippenger, who believed it was an original problem never before published:

A magnetic dipole $m\bar{1}_z$ is situated at the origin of cylindrical coordinates (r,ϕ,z). A charge of q is situated at (2,0,0). In a situation such as this it is well known that the Poynting vector does not vanish so there is an energy flux $\bar{S} = (1/\mu_0)E \times B$ and a momentum $\bar{P} = \epsilon_0 \bar{E} \times \bar{B}$ even though the configuration is entirely static (see, for example, Feynman's *Lectures* Volume II, Chapter 27). The problem is to find the total angular momentum of the electromagnetic field about the z axis; that is, find the integral

$$L_z = \int r\bar{1}_\phi \cdot (\epsilon_0 \bar{E} \times \bar{B})\, dV$$

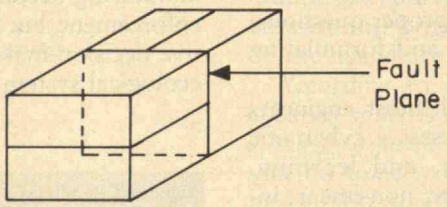
over all space. (Assuming q, m, and ϵ finite and nonzero, then L_z will be finite and not zero).

FEB 1 We begin our regular selection with a chess problem from Bob Kimble and an old lawyer, Alexander Alekhine: In a four-move chess game, White's moves were 1. P–KB3 2. K–B2, 3. K–N3, and 4. K–R4. On his fourth move, Black delivered mate. What were Black's moves?

FEB 2 Eric Jamin wants to know how many sequences can be formed using the 28 dominoes.

FEB 3 The following problem is from Mark D. Yellon: The word *FACETIOUS* contains all five vowels (no duplicates) and they occur in alphabetical order. Name another English word (no proper nouns) having the same properties.

FEB 4 Captain Eric B. Jamin notes that any system of locks requires a water supply at its upper level. For the Panama Canal this supply is Gatun Lake. The question is: for which vessel transiting via the canal from the Atlantic to the Pacific does more water flow out of Gatun Lake — an aircraft carrier or a rowboat?



FEB 5 We end with a practical problem from Frank Rubin: A man is to pack a carton with equal-sized rectangular blocks. To prevent shifting during shipping, there must be no fault in the packing. That is, no plane may cut through the carton without cutting a block. What is the smallest sized carton, in volume, which he can use if the blocks are 1 x 1 x 2? 1 x 1 x 3? 1 x 2 x 3? No credit can be given for the trivial solution in which the size of the carton equals the size of the block.

Speed Department

FEB SD 1 A quickie geometric problem from Mary Lindenberg: Three mutually tangent circles have centers A, B, and C and radii a, b, and c, respectively. The lengths of segments AB, BC, and CA are 17, 23, and 12, respectively. Find the lengths of the radii.

FEB SD 2 We close with a "problem" from Edward Friedman, who suggests that the advent of metrication in the United States makes useful a good understanding of unit conversions. Consider this one from an old 1953 M.I.T. physics quiz: "How many microphones are there in a megaphone?" or its companion: "How many millipedes are there in a centipede?"

Solutions

The following solutions are to problems published in the October/November, 1975, issue.

O/N 1 Given the following hands held by North and South, show how a bid of seven diamonds could be made; neither East nor West bid, and West's lead was ♠2.

♠ K
♥ A Q 9 8 7 6 2
♦ 9 8 4
♣ J 10

♠ A Q J
♥ J 10 5 3
♦ A K Q 5
♣ K 6

As I noted in December, William J. Butler, Jr., is our chief oddsmaker for bridge; he will not stoop to using the usual binomial approximations. Once again he seems to have given the most meticulous answer:

First, South must play for an even three-three break in diamonds. A four-two split is fatal even if the ♦J ♦10 is a doubleton. (The ♦A ♦K would catch the ♦J ♦10 and the ♦9 would win the next trick, but South would be unable to reach his hand to pull the last trump.) Since South's spades can be used to discard dummy's clubs, the problem boils down to how to play the heart suit. South's first six tricks are the high diamonds and high spades. (While leading the last diamond might induce one of the defenders to discard the outstanding small heart I will assume that they would discard clubs and not solve the declarer's problem.) At the seventh trick, South leads ♥J. (West could still make a mistake by "covering an

Possible West hands with . . .	No hearts	1 heart	2 hearts	Total
No spades	—	40	180	220
1 spade	180	3240	6480	9900
2 spades	6480	51840	60480	118800
3 spades	60480	282240	211680	554400
4 spades	211680	635040	317520	1164240
5 spades	317520	635040	211680	1164240
6 spades	211680	282240	60480	554400
7 spades	60480	51840	6480	118800
8 spades	6480	3240	180	9900
9 spades	180	40	—	220
				3695120

honor with an honor.") If West is void of hearts, the jig is up. If West plays the singleton ♥K, the problem is solved. If West plays the ♥4, South consults the table above:

Total possible West hands = $\binom{26}{13}$ = 26!/[13!(26 − 13)!] = 10,400,600
(Select 13 from 26 remaining cards)
Total West hands with three diamonds = $\binom{6}{3}\binom{20}{10}$ = 3,695,120
The "hearts" columns of the table are computed as follows:
$\binom{6}{3}\binom{9}{C}\binom{2}{H}\binom{9}{S}$, assuming three diamonds out of six, with
C = number of clubs
H = number of hearts, and
S = number of spades.
The "total" column of the table is computed as follows:
(6/3)(9/S)(20/CH), with three diamonds out of six and
S = number of spades
CH = number of clubs and hearts.
If West had only a singleton spade, there are 1,620 possible combinations that would allow him a singleton ♥4 and 6,480 combinations for a doubleton ♥K. Hence the odds are four to one in South's favor if he lets the ♥J ride. If West had two spades, the odds are 60,480 to 25,920 in favor of letting the ♥J ride. If West had three spades, the odds favor the finesse by 211,680 to 141,120. (This distribution may not be determined with precision, but the "spot" cards may offer a clue.) If West had four spades the choice is even. If West has more than four spades, then the play of the ♥A is indicated. If the only information on spade distribution gives West at least three spades but no more than six (all spot cards ignored), then the play of the ♥A is indicated. (Odds over finesse are 917,280 to 801,360.)

Also solved by Winslow H. Hartford, R. Robinson Rowe, Richard L. Hess, Elmer C. Ingraham, and the proposer, Kenneth Barbour.

O/N 2 Is it possible to construct a 3 x 3 x 3 magic cube in which the elements are not all identical?

Gerald Blum proves the following:
Lemma: The central element of a 3 x 3 magic square of magic sum S = S/3.
Proof of Lemma:
Let the magic square be

a b c
d e f
g h i

so that e is the central element. Write the following five of the eight "magic" equations:
a + b + c = S, g + h + i = S, b + e + h = S, a + e + i = S, c + e + g = S. From these we can quickly derive e + i = b + c and e + c = h + i, from which we obtain e − b = c − i and e − h = i − c. Adding these last two to b + e + h = S gives 3e = S or e = S/3. Q.E.D.

From this point on I will use the "pictorial" argument of Eric Jamin: Let s = S/3. Blum's Lemma shows us that the cube has these three layers piled on top of each other:

```
    s
s   s s s   s
    s
```

But to be a magic square,

```
  s                 s s s
s s s    must be    s s s   .
  s                 s s s
```

So we have:

```
  s       s s s       s
s s s     s s s     s s s   .
  s       s s s       s
```

The extra s's on the top and bottom cube come from looking at two vertical cross sections passing through the central element. But now the top and bottom must also be all s's.

Also solved by William J. Butler, Jr., Richard I. Hess, R. Robinson Rowe, Frank Rubin, Judith Q. Longyear, Avi Ornstein, P. V. Heftler, and the proposer, Roger Lustic.

O/N 3 A two-part problem:
A. Complex numbers of the form c= $a[e_0] + b[ie_1]$ have *one* kind of "complex conjugation," $c^* \equiv a[e_0] - b[ie_1]$. Here $[e_0][e_0] \equiv [e_0]$, $[e_0][ie_1] \equiv [ie_1][e_0] \equiv [ie_1]$, and $[ie_1][ie_1] \equiv -[e_0]$. This conjugation has the property $(cc')^* = c'^*c^* = c^*c'^*$. Note that ≡ is used to represent "equals by definition." Complex quaternions (or "hypercomplex" numbers)

$$q = a[e_0] + b[ie_0] + c[e_1] + d[ie_1] + e[e_2] + f[ie_2] + g[e_3] + h[ie_3] \equiv \sum_{n=0}^{3} a[e_n] + b[ie_n]$$

have *two* kinds of "complex conjugation" with the property $(qq')^* = q'^*q^*$. The hypercomplex number basis elements have a simple multiplication table: $[e_0] \leftrightarrow 1$ (i.e., $[e_0]$ acts like 1), $[ie_1] \leftrightarrow i$, $[e_1][e_2] = [ie_3] = -[e_2][e_1]$ and cyclic 1, 2, 3, $[e_1][e_1] = [e_2][e_2] = [e_3][e_3] = [e_0]$, $[ie_n] \leftrightarrow i[e_n]$ for multiplication. Find the conjugations q^* and $q^\#$ and prove them unique.
B. In physics, there is a 16-element extension of this number system which also seems to describe reality in a fundamental way. We can write it $E = a_n[e_n] + b_n[ie_n] + c[f_n] + d[if_n]$, where again sum on n = 0, 1, 2, 3. Let $E \equiv e + f$ for short. Then $E^+ \equiv e^* + f^\#$ and $E^\wedge \equiv e^\# + f^*$ and $E^\vee \equiv e^\# - f^*$, and all have the property $(EE')^{conj} = E'^{conj}E^{conj}$. The question is open as to whether any other conjugations can be defined with this property. The multiplication table is as follows: $e \leftrightarrow f$ and $e \leftrightarrow f$; that is, f is like e with respect to $()^*$ and $()^\#$; e and f are like (+) and (−) in multiplication, $ef \rightarrow f$, $ee \rightarrow e$, $ff \rightarrow e$, $fe \rightarrow f$; if f is the *left* multiplier only, then fe is like ee given before ($[f_1][e_2] = [if_3]$); if f is the *right* multiplier then $()^{\#*}$ is taken on the *left* before the regular multiplication is done ($[e_1][f_2] \rightarrow [e_1]^{\#*}[f_2] = -[e_1][f_2] \rightarrow -[if_3]$ and $[if_1][f_2] \rightarrow [if_1]^{\#*}[f_2] = +[if_1][f_2] \rightarrow -[e_3]$).

The proposer, James Edmonds, offers:

$$q^*\left(\sum_{n=0}^{3} a^n(e_n) + b^n(ie_n)\right) = \sum_{n=0}^{3} a^n(e_n) - b^n(ie_n)$$

$$q^\#\left(\sum_{n=0}^{3} a^n(e_n) + b^n(ie_n)\right) = a_0(e_0) + b_0(ie_0) - \sum_{n=1}^{3} a^n(e_n) + b^n(ie_n)\,.$$

Richard I. Hess submitted the following:
Find the conjugations satisfying $(qq')^* = q'^*q^*$, where q and q' are quaternions.
1. Each $q = ae_0 + be_1 + ce_2 + de_3$, where a, b, c, and d are complex numbers.
2. The multiplication table is as follows:

	e_0	e_1	e_2	e_3
e_0	e_0	e_1	e_2	e_3
e_1	e_1	e_0	ie_3	$-ie_2$
e_2	e_2	$-ie_3$	e_0	ie_1
e_3	e_3	ie_2	$-ie_1$	e_0

3. Complex conjugation must generally be defined as:

$$q^* = \begin{bmatrix} C_{00} & C_{01} & C_{02} & C_{03} \\ C_{10} & C_{11} & C_{12} & C_{13} \\ C_{20} & C_{21} & C_{22} & C_{23} \\ C_{30} & C_{31} & C_{32} & C_{33} \end{bmatrix} \begin{bmatrix} a \\ b \\ c \\ d \end{bmatrix} = cq$$

4. Let the columns of C be C_0, C_1, C_2, and C_3.
5. $(e_0e_0)^* = e_0^*e_0^* \Rightarrow (e_0 - e_0^*)e_0^* = 0 \Rightarrow$ either $e_0^* = 0$ or $e_0^* = e_0$.
6. Suppose $e_0^* = 0$, then $(e_0e_i)^* = e_i^*e_0^* \Rightarrow e_i^* = 0$. Thus one conjugation is

$$C = \begin{bmatrix} 0000 \\ 0000 \\ 0000 \\ 0000 \end{bmatrix} ; q^* = 0 \text{ for all } q.$$

7. Suppose $e_0^* = e_0$, then $(e_i e_j)^* = e_0 = e_i^*e_i^* = C_iC_i \Rightarrow$
$C_{0i}^2 + C_{1i}^2 + C_{2i}^2 + C_{3i}^2 = 1$
$2C_{0i}C_{1i} = 2C_{0i}C_{2i} = 2C_{0i}C_{3i} = 0$
Either $C_{1i} = C_{2i} = C_{3i} = 0$; $C_{0i} = \pm 1$ (i = 1,2,3)
Or $C_{0i} = 0$; $C_{1i}^2 + C_{2i}^2 + C_{3i}^2 = 1$ (i = 1,2,3)

7a. Suppose $C_{1i} = C_{2i} = C_{3i} = 0$;
$C_{0i} = \pm 1$ (i = 1,2,3)
then $(e_i e_j)^* = -ie_k^* = e_j^*e_i^*$ (i,j,k cyclic) $\Rightarrow -iC_k = C_jC_i = \pm e_0 \Rightarrow$ contradiction.

7b. Suppose $C_{0i} = 0$, $C_{1i}^2 + C_{2i}^2 + C_{3i}^2 = 1$ (i = 1,2,3)
then $(e_i e_j)^* = -ie_k^* = e_j^*e_i^*$ (i,j,k cyclic)
$\Rightarrow C_{1i}C_{1j} + C_{2i}C_{2j} + C_{3k}C_{3j} = 0$ $(i \neq j)$
$C_i \cdot C_j = C_k$ (i,j,k cyclic)
These conditions force the 3 x 3 part of C to be orthogonal with determinant.
$C = +1$ and $e_0^* = e_0$.

8. Two types of conjugation are C = 0 and C = orthogonal. Example:

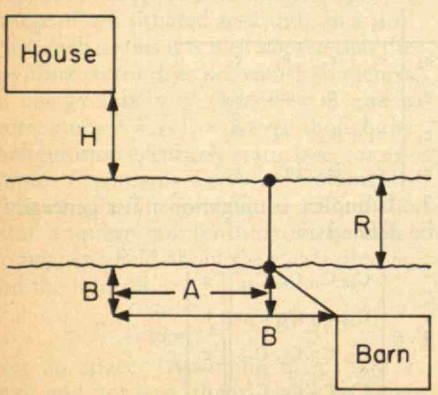
$$e_0^* = e_0$$
$$e_1^* = \sqrt{1/2}e_1 + \sqrt{1/2}e_3$$
$$e_2^* = e_2$$
$$e_3^* = -\sqrt{1/2}e_1 + \sqrt{1/2}e_3$$

Judith Q. Longyear also responded.

O/N 4 A farm is cut by a river flowing from east to west, the house on one side, the barn on the other. The farmer wants to build a north-south bridge from his house to his barn. Where should he locate the bridge to minimize his walk from house to barn?

The following pair of solutions were submitted by James W. Shearer:

First, consider the straightforward analytical approach, where distances are defined as shown.



Let y be the farmer's walking distance; then

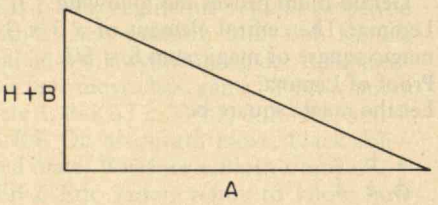
$$y = (H^2 + X^2)^{1/2} + R + [B^2 - (A - x)^2]^{1/2}.$$

We then minimize y(X) by setting dy/dx = 0:

$$0 = X/(H^2 + X^2)^{1/2} + (X - A)/[B^2 + (A - X)^2]^{1/2}$$
$$1/[(H/X)^2 + 1] = 1/[(B/A - X)^2 + 1],$$

whence $X = HA/(H + B)$ and $A - X = BA/(H + B)$.

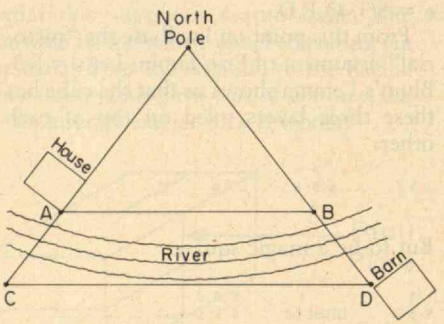
A more intuitive way of arriving at the solution is to realize that the distance R across the north-south bridge is invariant. So the minimum distance is given by the diagonal of the triangle with sides A and (H + B). The value of X needed to locate the bridge is then found from similar triangles:



$X/H = A/(H + B)$.

For another method, consider this response from Mark F. Mitchell:

It is assumed that the problem lies entirely within the Northern Hemisphere. To make this answer obvious by inspection, the sketch has been redrawn in Lambert Conformal Conic Projection so that the meridians converge at the North Pole. Dimensions are, of course, distorted.



Line AB is the shortest east-west path, so that a bridge erected at BD would afford the shortest available route from house to barn.

Also solved by R. Robinson Rowe, Glenn Ferri, R. V. Heftler, Raymond Gaillard, W. A. Schoenfeld, Antonio Carlos Barbosa De Oliveria, Jack Parsons, Richard Hanau, John E. Prussing, Mickey Haney, David J. Pogoff, Charles R. Owen, Jim Ritcey, Richard Ryan, George D. Lawrence, Neil E. Hopkins, Ted Mita, Judith Q. Longyear, Winslow H. Hartford, Gerald Blum, Eric Jamin, William J. Butler, Jr., Frank Rubin, Richard I. Hess, and the proposer, Ray Brinker.

O/N 5 Prove that any set of n integers (not necessarily distinct) contains a nonempty subset whose sum is divisible by n.

I liked this problem, and so did several readers. The solution selected, from Judith Q. Longyear, seems particularly clear.

Let $A = \{a_1, a_2, \ldots, a_n\}$ be a set of n integers. The n sums a_1, $a_1 + a_2$, $a_1 + a_2 + a_3, \ldots, a_1 + \ldots, + a_n$ have various remainders on division by n. Let us say $a_1 + \ldots, + a_i$ leaves remainder X_i. Then there are n sums and n possible remainders 0, 1, . . ., n − 1. If some $X_i = 0$ then $a_1 + , \ldots, + a_1$ is a multiple of n. If not, then there must be $i<j$ for which $X_i = X_j$ (although the sums are possibly different.) But then $a_{i+1} + a_{i+2} + \ldots + a_j = a_1 \ldots + a_j - (a_1 + \ldots + a_i)$ leaves the remainder $X_j - X_i = 0$. The set $\{a_{i+1}, \ldots, a_j\}$ is not empty since $i < j$.

Also solved by Eric Jamin, William J. Butler, Jr., Frank Rubin, Richard I. Hess, Ted Mita, P. V. Heftler, R. Robinson Rowe, Peter Kleeman, Joe Martin, and Richard C. Bradley.

O/N SD 1 Maine, Idaho, Utah, and Iowa do not recognize hereditary barrenness as legal justification in a suit by a husband for divorce. Why?

As you know I do not usually print solutions to speed problems. However, I must do so this time as Bob Horvitz gives an important correction. My wife, Alice, (an M.D.-Ph.D. student) says that Mr. Horvitz is right. So I guess I was wrong. In fact, I've been wrong for over a dozen years. I first heard a variant of this problem when in high school. I take some comfort in my company as I have the greatest respect for the proposer, R. Robinson Rowe. Mr. Horvitz writes:

Unless I've missed the point of **O/N SD 1**, I think you and R^3 may have forgotten some elementary genetics. Hereditary barrenness is indeed quite possible. The simplest way for it to occur would be for the two parents to be of an Aa genotype, where A = normal and a = barren, with a recessive to A; hence an Aa individual is capable of reproducing. If two such Aa individuals have children, half will be aa and thus be of hereditary barrenness.

There are other, less likely ways for an individual with heriditary barrenness to arise. Consider two examples:

1. This person could carry a spontaneous (dominant) mutation, hence making the genotype of her/his parents irrelevant.
2. One parent could carry a second mutant gene which "suppresses" the effect of a gene for hereditary barrenness she/he also carries; i.e., where B = barrenness and b = normal, if B is dominant to b and if S is capable of suppressing the effect of B and is dominant to s; a parent of genotype sSBs would not be barren but could produce a barren child (ssBb) as a result of mating with a normal (e.g., ssbb) individual.

I suspect that one could come up with numerous examples of hereditary barrenness from the medical literature, but I hope that for a mathematics column a theoretical result is good enough.

Better Late than Never
J/A 3 Frank Carbin has responded.
J/A 4 R. L. Bishop has responded, and I failed to mention the proposer.
J/A 5 J. Estermann has responded.

Proposer Solutions to Speed Problems
SD 1

$$\begin{aligned} a + b &= 17 \\ b + c &= 23 \\ c + a &= 12 \\ \hline 2(a + b + c) &= 52 \\ a + b + c &= 26 \end{aligned}$$

Subtract each of the first three equations from the last to obtain a = 3, b = 14, and c = 9.

Allan J. Gottlieb studied mathematics at M.I.T. (S.B. 1967) and Brandeis (A.M. 1968, Ph.D. 1973); he is now Assistant Professor of Mathematics at York College of C.U.N.Y. Send problems, solutions, and comments to him at the Department of Mathematics, York College, 150-14 Jamaica Ave., Jamaica, N.Y., 11432.

Letters

Continued from p. 4

not sleep. He sat up all night to write a poem in praise of the young researchers. To scientists all over China, this spontaneous act provided more incentive than any monetary reward possibly could.
T. C. Tsu
Pittsburgh, Pa.

Gas Is Better
Whereas we agree with the overall methodology employed by Ogden Hammond and Martin B. Zimmerman in "The Economics of Coal-Based Synthetic Gas" (*July/August, pp. 42-51*), we do not concur with their conclusion. There are two basic oversights which, it turns out, were responsible for making the case for electric energy over gas energy for space heating.

First, with a few exceptions for "town gas" and hydrogen production at relatively small output rates, the gas-from-coal technology which forms the basis of the author's analysis is pre-commercial when measured against current U.S. gas demands. Current coal-to-gas technology therefore lacks the cost-saving developments and technological improvements that would surely ensue in the first few years of any new commercial process. This fact must be faced by any utility pondering the decision to invest, or not to invest, in any given technology. Consolidated Natural Gas Co. has invested large sums in coal reserves, and is actively evaluating sites for gas-from-coal facilities. But we are delaying commitment to commercial plants representative of the technology cited in the article in the belief that there will be far more attractive options available when we are ready to proceed.

Second, when the authors compare an electric heat pump with a coefficient of performance (COP) of 2.4 and a gas burner with an efficiency of 0.5 they are comparing a thing of the future with something becoming rapidly out-of-date. Specifically, the best of presently available electric heat pumps, operated in our service area, achieve a COP (or, we would prefer, an SPF, or season's performance factor) of 1.7. One of the electric utilities operating in our service area (Cleveland Electric Illuminating Co.) will not vouch for an SPF of more than 1.5 when asked by a customer what can be expected. A COP of 2.4 over a season (in our service area) would require an electric heat pump with extra-large heat transfer surfaces plus some means of modulating the compressor. These features may become practical some day, but are not now available.

The gas burner with a COP of 0.5 represents the worst applications of past-technology gas heating equipment.

Until the electric utility industry finds a practical means of applying all of the waste heat rejected by its generating facilities to space heating, there is no way that electric energy can match the bottom-line efficiency of the on-site use of gas.
L. G. Massey
Cleveland, Ohio

Mr. Massey is Associate Director, Research of Consolidated Natural Gas Service Co.

Boulding

Continued from p. 5

in it, we can visualize the problem. This is an invitation to contemplate appalling human catastrophe, made worse by climatic instability. Yet neither Bangladesh nor anyone else is doing anything about it. The second Club of Rome report, *Mankind at the Turning Point,* by Mihajlo Mesarovic and Eduard Pestel, suggests that catastrophe is nearly inevitable in a large part of the tropics without rapid reduction of human fertility and large transfers of capital from the rich countries to the poor. It is not wholly certain, of course, that these measures are necessary to secure the tropics from disaster, but the probability is high. The probability that they will not be carried out seems even higher. Perhaps the most that can be hoped is that we will learn how to learn from catastrophe when it occurs.

The breeder reactor is fraught with even more awesome uncertainties. Plutonium is probably the most poisonous substance known to mankind. It has a half-life of about 24,000 years, so that after 100,000 years an eighth of it remains in the environment. It will be produced in increasing quantities by the presently contemplated breeder reactors. Plutonium involves a low probability of very large catastrophes, increasing as times goes on unless a substitute source of energy is found. If the probability of a major catastrophe due to plutonium is only 0.1 per cent a year, the probability in 100,000 years is so high as to be virtually certain. With plutonium, we risk profound change in the planet's evolution. I confess I am glad the decision to build the breeder does not rest with me.

Kenneth E. Boulding is Professor of Economics and Director of the Institute of Behavioral Science at the University of Colorado.

Nisbet

Continued from p. 11

viduals fall victim before the age of 40, a fact which testifies to the wide range of human susceptibility. We must remember that in estimating the risks posed by very low levels of carcinogens in the environment, we are ipso facto concerned with predicting the response of the most highly susceptible individuals. There is no evidence in research on cigarette smoking of either a threshold dose or a threshold time.

The data on lung cancer in nonsmokers suggest a probability comparable to smoking almost one cigarette per day. Thus, nonsmokers are already at substantial risk. It is not clear to what extent their lung cancer is caused by other carcinogens and to what extent it is caused by involuntary exposure to cigarette smoke. But it is clear that nonsmokers are well-advised to avoid cigarette smoke: the more susceptible among them are expected to be affected by any incremental increase in dose.

Ian C. T. Nisbet, who writes regularly for Technology Review, *is Associate Director of the Scientific Staff of the Massachusetts Audubon Society. His Ph.D. (in physics) is from Cambridge University.*

Book Reviews

Continued from p. 29

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cycle such energy, Messrs. Schoen, Hirshberg, and Weingart describe some that promise to minimize the use of fossil fuels.

If we have done all we can as conscientiously as we are able, and if our clients still insist on more heat, air conditioning, or light — or worse still, if local building codes insist on such design standards — then we will at last have to install traditional mechanical and electrical contrivances. The cost of such pampering is going to be very high, and we can expect that many will adjust their comfort requirements rather than pay it.

Rethinking Energy

These two books are by young architects and provide a wealth of information for anyone interested in rethinking energy use in buildings. In fact, Mr. Steadman's book is encyclopedic in its treatment of solar energy, wind power, and waste recycling technologies. Mr. Schoen and company spend more time analyzing the U.S. building industry and its historical resistance to innovation. This problem is especially important for policymakers concerned with the rapid adoption, diffusion, and use of new, or newly rediscovered, technologies.

Both these books are the result of intellectual bootlegging, a time honored tradition in scholarly studies. Alexis de Tocqueville came to America in 1835 to study prisons and wrote *Democracy in America*. Benjamin Franklin scribbled a few notes of advice to his son that became his *Autobiography*, and Henry Adams was just following the Adams' tradition of keeping a journal when he produced his seminal *Education of Henry Adams*.

In the same fashion, Philip Steadman was supposed to report to the Academy of Natural Sciences on how to design its new building, and instead wrote *Energy, Environment, and Building*. Richard Schoen and company were originally commissioned by the Ford Foundation's Energy Policy Project to report on total energy systems on the urban scale, and ended with this scholarly analysis of the building industry's resistance to innovation.

One hopes that readers of these books will make similar intellectual leaps, discovering that conservation is not starving poorly-designed mechanical monsters but designing for human comfort buildings that are sensitive to climatic conditions and utilize a minimum of fossil fuels.

John P. Eberhard is an architect, former Dean of Architecture, State University of New York at Buffalo, and President of A.I.A. Research Corp., a nonprofit organization established by the American Institute of Architects. He holds a master's degree in management from M.I.T.

Institute Review

In This Section

$52 Million "Early Returns" on Campaign

Gifts to the M.I.T. Leadership Campaign had reached $52 million in December, when Howard W. Johnson, Chairman of the Corporation, made his first report as Campaign Co-chairman to the Development Committee of the M.I.T. Corporation.

That total is up $9 million from the nucleus fund of $43 million reported when the $225 million Campaign was opened in April, 1975. It's an "early return," said Mr. Johnson, because most Campaign efforts during the summer and fall were devoted to "initial discussions with the Institute's great benefactors" and to enlisting Steering and Leadership Committees.

The Leadership Committee continues to grow. As of December the total was 41 alumni in 30 Campaign areas, representing 21 states and three foreign countries:

Yaichi Ayukawa, '52, Tokyo; Hal L. Bemis, '35, Philadelphia; Earl L. Bimson, '43, Arizona; Paul M. Cook, '47, San Francisco; Charles Diebold III, '58, Buffalo; Kenneth-Hung Fang, S.M. '61, Hong Kong; W. H. Krome George, '40, Pittsburgh; Samuel A. Groves, '34, Miami; Sheridan C. F. Ing, '45, Hawaii; J. Kenneth Jamieson, '31, New York (Chairman for New York); Franklin M. Jarman, '53, Tennessee; Breene M. Kerr, '51, Oklahoma; David I. Kosowsky, Sc.D. '55, Boston.

Paul S. Lam, '59, Hong Kong (Chairman for Hong Kong); Norman B. Leventhal, '38, Boston; Samuel E. Lunden, '28, Los Angeles; Gilbert B. M. Mar, '52, Taiwan (Chairman for Taiwan); Leonard Mautner, '39, Los Angeles; Charles B. McCoy, S.M. '32, Wilmington; Robert E. Meyerhoff, '44, Baltimore (Chairman for the Mid-Atlantic — Southern District); E. Kirkbride Miller, Jr., '41, Baltimore; William H. Mills, '34, Tampa-St. Petersburg; Joe F. Moore, '52, Houston; Thornton W. Owen, '26, Washington, D.C.; John S. Reed, '61, New York

Gilliland Professorship

Edwin R. Gilliland, Sc.D. '33, was a member of the staff of the Department of Chemical Engineering from even before he received his doctorate until his death in 1973, and in this period he was widely acclaimed for his leadership of the Department (he was Head from 1960 to 1969) and for research contributions on the fractional distillation of petroleum, the production of synthetic rubber, and the purification of water.

Now Dr. Gilliland's memory is to be honored by a Professorship for which a $1 million fund is to be completed by March. Howard W. Johnson, Chairman of the Corporation, says it will be a fitting commemoration of Dr. Gilliland's "distinguished contributions to chemical engineering education and his prodigious research achievements which together have advanced our industrial technology on a wide scale."

And Paul M. Cook, '47, President of Raychem Corp. who is Chairman of a National Sponsoring Committee for the Professorship, says the $1 million fund "will bring timely and much needed help to the Department." He points to its work in energy resources, environmental quality, basic materials, and chemical processes — "strategic inputs to the solution of urgent national problems . . . which are fundamental to our industrial strength," says Mr. Cook.

The Gilliland Professorship is part of the $50 million goal for faculty endowment within the $225 million Leadership Campaign.

(Deputy Chairman for New York); Howard L. Richardson, '31, Hartford; Wylie S. Robson, S.M. '56, Rochester.

Robert B. Semple, '32, Detroit; Tseng Y. Shen, '38, Taiwan; Charles H. Smith, Jr., '42, Cleveland; Goff Smith, S.M. '53, Chicago; Jack C. Tang, '49, Hong Kong; Harold E. Thayer, '34, St. Louis; C. Vincent Vappi, '48, Boston; Edward O. Vetter, '42, Dallas-Fort Worth; D. Reid Weedon, Jr., '41, Boston (Chairman for Greater Boston); Thomas R. Williams, S.M. '54, Atlanta; Thornton A. Wilson, S.M. '53, Seattle; John E. Wood III, Ph.D. '39, Alabama; Frank S. Wyle, '41, Los Angeles (Chairman for Los Angeles); and William R. Zimmerman, '48, Los Angeles.

Mr. Cook has also been named Chairman of a National Sponsoring Committee for the Edwin R. Gilliland Professorship of Chemical Engineering, whose $1 million goal is to be completed early in March.

There have been "many discussions with . . . potential major donors to the Campaign," Mr. Johnson told the Corporation Development Committee late in the fall, and he described the response as "warm and encouraging." He also paid tribute to alumni who have joined the Leadership Campaign organization — "an extraordinary and dedicated group of volunteers," Mr. Johnson said. □

Research: New Role, Problems, Says Jones

Three significant new trends in research at M.I.T., says Thomas F. Jones, Sc.D. '52, Vice President for Research:

— Research commitments are growing in total volume but — especially federal commitments — shrinking in individual amounts, a way of saying that many of today's federal grants are for small parts of large problems, for one year of work on a project which should be part of a comprehensive program.

— Research groups supported by major program grants — for example, the Research Laboratory for Electronics and the Bitter National Magnet Laboratory — are "seriously short of funds" because their grants do not cover sharply escalating energy costs.

— Undergraduates are turning more and more to research laboratories for learning — "a new educational mode," says Dr. Jones, pioneered at M.I.T. by the Undergraduate Research Opportunities Program (U.R.O.P. — *see February, 1973, pp. 78-83*).

Dr. Jones told members of the M.I.T. Corporation at lunch this fall that he is proud of the continuing research achievements of the Institute — "earthshaking research is a tradition" here, he said, citing work in public health, computers, petroleum refining, radar, and high-speed photography, with which everyone in his audience was familiar. The achievements continue, he said: M.I.T. physicists in the Bitter National Magnet Laboratory have this fall "approached nearer to the critical curve for sustained fusion than anyone else," and the Institute is now busy putting together a Center for Fusion Research to strengthen relevant activities throughout the campus.

Predictions for the current year are for increases of 12 per cent in total research support, said Dr. Jones — industrial support will go up as much as 20 per cent, federal support about 11 per cent; and there are "excellent prospects" for major funding from the Energy Research and Development Administration. But he is uneasy about pressure on Congress to "discard peer review in favor of more political processes" for evaluating research proposals, about trends to convert research proposals initiated at M.I.T. into projects for which funding is finally given to others, about the trend to fund short-term projects instead of long-term programs. All these waste overhead and increase anxiety, said Dr. Jones, and "frenetic behavior is counterproductive to research."

New Teachers, New Learning

Can M.I.T. maintain a flow of creative young people into its research laboratories when fixed endowment resources constrain new faculty appointments?

A timely — and crucial — question, Dr. Jones told the Corporation, especially in view of students' growing interest in research as a vehicle for education. Dr. Jones' answer is to think about "new staffing models" for research — appointments to a research staff which will be at faculty level and whose members will have opportunities and responsibilities for teaching.

He thinks such appointments would strengthen U.R.O.P. at a time when it has proved its value and popularity — some 6,000 students have participated since U.R.O.P.'s founding, and Dr. Jones is convinced by U.R.O.P.'s demonstration that being apprenticed to a faculty member in research "is an ideal way to learn how to learn."

An Ombudsman for Research

Gregory Smith, '30, a member of the M.I.T. Corporation who has chosen to devote much of his time and effort in retirement to helping U.R.O.P., credits the plan's success to Professor Margaret L. MacVicar, '65: she "delivered U.R.O.P., brought it up through infancy, and now cares for it in healthy adulthood," he told members of the Alumni Advisory Council in the fall.

Professor MacVicar is a bit more modest; the idea of "students and teachers working together" has been around M.I.T. at least since 1905, when President Henry S. Pritchett used the phrase in his annual report, she told the Alumni Advisory Council. But she thinks her office provides "a new kind of tender, loving care for skillful undergraduates . . . who want to join faculty as colleagues on problems that intrigue both of them."

Today the U.R.O.P. office serves some 2,000 undergraduates — a kind of informal ombudsman — "scrounging, listening, responding, getting people together" — whose principal job is "to sense when there's a need — bureaucratic or substantive" — and work out a solution, said Professor MacVicar. U.R.O.P. is nothing like a science fair — do a project, exhibit it, and that's the end. It's a much more intensive, complete learning experience; and so termination is one of the problems to which Professor MacVicar and her colleagues try to be especially sensitive. The problem, she told the alumni, is to "know when you're finished," when you've learned all you want to know, and should go on to something new, "and then to take leave responsibly." □

Alumni Helping U.R.O.P.

More than 400 of the 2,000 M.I.T. undergraduates now working in U.R.O.P. (the Undergraduate Research Opportunities Program) are doing their research in off-campus laboratories — hospitals, engineering firms, even law offices and city government headquarters. Some alumni in Boston-area firms have already become sponsors of these projects, but more alumni participation is needed, Professor Margaret L. MacVicar, '65, told members of the Alumni Advisory Council last fall. Some suggestions:

— Let an alumnus join in a three-way partnership with student and faculty member by defining a research project. The U.R.O.P. office will help, and then will seek a faculty member interested in co-sponsoring it and a student whose inclinations it meets.

— Offer surplus research equipment or space. U.R.O.P. is sometimes asked to fulfill "weird needs," said Professor MacVicar, and alumni may be able to help.

— U.R.O.P. students report on their work at seminars and symposia; alumni interested in the field would be welcome to listen, ask questions, and comment.

— U.R.O.P. students are also a good audience, said Professor MacVicar, and alumni who have problems which might intrigue undergraduates should themselves offer to present seminars.

Professor MacVicar wants to think of M.I.T. as "a community of learners," and she thinks the alumni are today "the missing component which is needed for the students' and the institution's vitality."

Bennis: University Leaders Must Reclaim Their Lost Roles of True Leadership

He's in the midst of "a buzzing confusion that often seems unmanageable." And his hands are tied, his strategies limited to "consulting, pleading, trotting, temporizing, putting out fires, either avoiding or more often taking too much heat and spending too much energy in doing both."

These are the frustrations of today's university president, says Warren G. Bennis, Ph.D. '55, President of the University of Cincinnati. He confronts "innumerable bonds" — financial crisis; governmental requirements; litigation; the moral and sometimes legal pressures of organized parents, consumers, and environmentalists; fragmentation of constituencies.

"The crisis calls for leadership, but we're not leading," Dr. Bennis told the Cincinnati Historical Society early this year. "The irony of our times is that precisely when the credibility of leaders is at its lowest, when we survivors in leadership positions feel inhibited from exercising what little power we have, we most need people who can lead, who can transcend that vacuum."

Proliferating Constituencies, Growing Constraints

The time was when a university president could "propose and dispose. Like a Ford or a Carnegie, he could decide." Not so today, said Dr. Bennis, listing a handful of issues, sometimes contradictory, which act as constraints:

— Today's president has to consider the effects of his decisions on students, faculty, city councilmen and state legislatures, alumni, parents, the federal government . . . Even within these structures, special interests demand hearings — women's groups, gay liberations, organizations of black students and staff. "The university is a brilliant example of an institution that has blunted and diffused its main purposes through a proliferation of dependence on external structures of patronage."

— The university is in the midst of "an increasingly litigious environment." Dr. Bennis found himself and his university defendant in some 40 lawsuits last fall, and he concluded that he could "no longer make even a trivial decision without consulting our lawyers."

— Operations must now be carried out "in a goldfish bowl." Federal requirements make all records available to students and parents, for example, and students want a voice in budget decisions at all levels.

— It's a period of financial crisis; no university president can do everything he wants to do, or his constituencies want done. "We have the size and scope of a big business, with few if any of its opportunities to increase our productivity. Nor can we increase our 'profits,' " said Dr. Bennis, "because our products are not objects but people."

The Need for Leadership

"We are an anvil on which the hammer of a fragmented society pounds away," said Dr. Bennis, "and the anvil chorus is a dissonance, not a harmony."

A solution? No simple one, thinks Dr. Bennis, but he identified one ingredient for his Cincinnati audience:

"We must recognize that academic leadership must develop the vision and strength to call the shots.

"There are risks in taking the initiative," he said, "but the greater risk is to wait for orders.

"This means that colleges administrators at every level must *lead,* not just manage. This means that colleges and universities have to recognize that they *need* leadership, that their need is vision, energy, and drive rather than a safe figurehead." □

Economist for Cambridge

An economic adviser to the presidents of Harvard and M.I.T.? There is one, for the first time.

Penelope Hedrick Schafer will work at the Harvard-M.I.T. Joint Center for Urban Studies, and her job will focus chiefly on how the two institutions can help economic developments affecting Cambridge and how the two institutions can affect them.

James L. Sullivan, City Manager, welcomes Ms. Schafer's help — another step, he says, in the city's effort to take "a good hard look at the patterns and processes of employment and economic development" there. And he hopes Ms. Schafer will marshal faculty expertise on problems and opportunities which she identifies.

For herself, Ms. Schafer expects her work to focus on long-term factors — trends in employment, work force, and tax base; new economic activities which the city should encourage, and how to encourage them; redevelopment; and taxation.

Ms. Schafer studied economics at Radcliffe (A.B. 1966) and has just received her Ph.D. in urban planning from Harvard, where she has been an instructor in urban finance and municipal budgeting. Her husband is Robert Schafer, Associate Professor of City and Regional Planning at Harvard.

Draper: A $100 Million Year, and a "We Can Do It" Optimism

Operations of just over $100 million, up from $87.3 million in the previous year, are reported by the Charles Stark Draper Laboratory in 1974-75. Personnel levels were virtually unchanged, say Robert A. Duffy, President, and Albert G. Hill, Chairman of the Laboratory, in its annual report, but "the mix of our business" is changing, they write.

"National security is our primary concern," Mr. Duffy and Dr. Hill say in the Laboratory's second annual report, and its major activities continue to be centered in inertial guidance, navigation, and control for the military. But the trend, they think, "is away from 'hand' tasks and toward 'head' tasks . . . less emphasis on hardware development and more on design, analysis, evaluation, and other such intellectual pursuits."

Draper Laboratory's leaders see that change as consistent with "a national syndrome," which they regret. "The traditional American 'hard-scientist,' from backyard mechanic to current gods of invention, exploration, production, extraction, agronomy, and so on, is being made to be a lesser factor in American life than the importunities of the 'soft' sciences. . . . Fewer people are attracted to the rigors of tough disciplines and more toward the easy life of minimal effort and mediocre results.

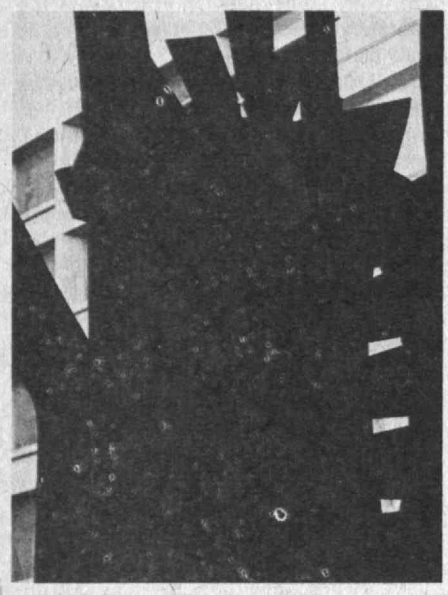
"We in this Laboratory not only deplore this trend but intend to combat it," write Mr. Duffy and Dr. Hill. "We intend to maintain our 'we can do it' capability and to be prepared to pick up our proper burden again when the pendulum, weary with talk, swings toward deeds."

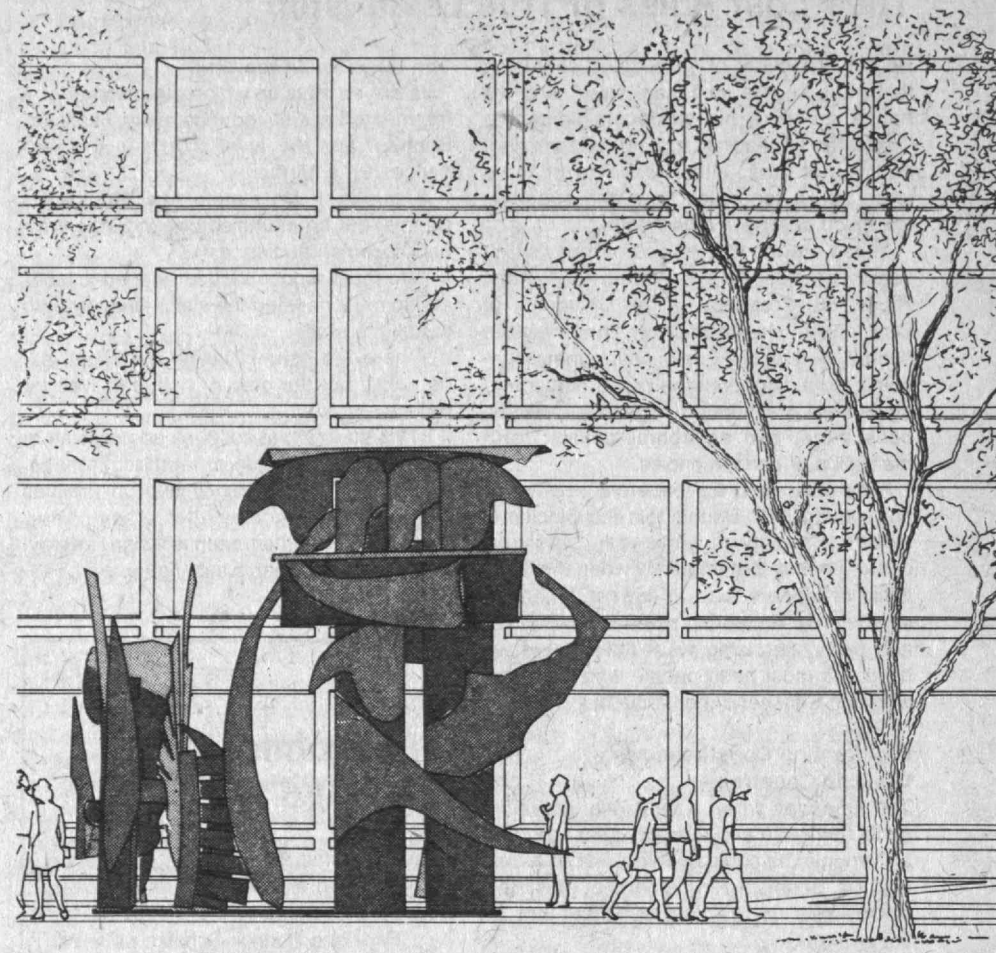
Translating Science to Society

In addition to work in guidance and control, the Draper Laboratory's second annual report since divestment from M.I.T. describes research aerial topographic profiling, deep submergence rescue vehicles, ocean mineral recovery systems, fault-tolerant computer software, computer applications for automotive and consumer durable studies, high-energy lasers, oceanographic instrumentation and mooring systems, computer-aided design and manufacturing, and remote data processing.

The Laboratory's role, says Mr. Duffy, "is that of translator, taking from science, which is not at all mission-oriented, the knowledge required for the resolution of societal needs and converting it in the form of design and prototype hardware to manufacturable and operable machinery," a bridge, he says, between society's needs for innovation and industry's needs for profits. □

"Transparent Horizon": Ten Tons of Black Steel or "Hard-Edged Lyricism"





"Transparent Horizons" by Louise Nevelson. Above left: the artist visits with Professor Wayne V. Andersen, Chairman of the Committee on the Visual Arts, and President Jerome B. Wiesner (right). (Photo, bottom left: Daniel F. Lam)

A new piece has joined what is becoming a significant collection of modern sculpture adorning the M.I.T. campus. Some observers find it simply ten tons of black steel measuring 20 feet high by 21 feet long — a shallow, open construction of abandoned metal scraps and fabricated shapes. Others, even within two weeks of its erection, attributed to "Transparent Horizon" a "hard-edged lyricism . . . crispness . . ."

M.I.T.'s newest sculpture is by Louise Nevelson, a distinguished and controversial American artist. "Transparent Horizon" stands at the north end of the East Campus "parallels," adjacent to the new chemical engineering building designed by I. M. Pei, '40, which is now nearing completion.

In a brief site ceremony this winter, Ms. Nevelson joined Professor Wayne Andersen, Chairman of the Committee on the Visual Arts; Howard W. Johnson, Chairman of the Corporation, President Jerome B. Wiesner, Mr. Pei, and Professor Raymond F. Baddour, '49, Head of the Department of Chemical Engineering. Hearty applause saluted the artist later during a "conversation" between Ms. Nevelson, Professor Andersen, and an audience.

At another meeting a few days later, a small but vociferous group of disgruntled students faced Professor Andersen to complain. "It's up to you to justify that it is a work of art. We're scientists here, we're traditional . . ." "It could be a painstakingly done great work of art or the remnants of an auto junkyard." "Art has one function — to please people who look at it. If it doesn't fulfill that, what good is it?"

Some indignation centered on the cost — $87,000. Professor Andersen explained M.I.T.'s policy of alloting 1 per cent of the total cost of a new building for art. And the payment is for fabrication only, not for the artist's effort, which was donated.

Safety was an issue: "I can bump into a tree playing frisbee and be all right; if I bumped into the sculpture I'd be impaled." General outrage: "I'm a resident of East Campus and regard it as disgusting that every time I walk out I have to look at such a thing. . ." "Why was I not involved in the decision-making process? I want to know the procedure — to make sure it isn't repeated. . ." "It was plunked down in space people define as their own. . ." "The sculpture is made for the art historian or artist, not for people."

Some in the audience held a vastly different view. "I went and looked and I thought it was beautiful. . ." "It has a hard-edged lyricism, a crispness to it — from human to building it makes a nice step up — greys, earth tones, not crass like pink would be. It doesn't stick out physically (although some say it does) . . . it makes a nice balance in working with the environment. It doesn't press itself in on you too much."

Professor Andersen remembered: "Not many of you were here ten years ago, when this place was all grey and pea green. Halls were bare, there were no lounges, all posting was in two standard sizes behind glass, locked with keys and padlocks."

And an artist suggested a reason for controversy: "New art is always on a frontier — it alters your ability to perceive space; it takes a while for the majority of people to accept what a few enjoy at first. . . . The Calder was protested, but it became an important part of the M.I.T. environment. I could cite a whole history of sculpture which met with protest — like Michelangelo's Piéta. . . . Sculpture has an extraordinary character, a presence, and that is why it upsets — suddenly it intrudes. I'm always wary of art that evokes only pleasant comments." — *M.L.*

A Plea for a New Role in Art

Amidst a "crisis of scale," art can help technological man rediscover his true identity, says Professor Gyorgy Kepes, founder of M.I.T.'s Center for Visual Studies. "I believe the artist's imagination and sensitivity has the key to bring to the 20th century something it hasn't had until now," Professor Kepes said in his Killian Lectures at M.I.T. this winter.

Some of his views on "means and meanings in todays art":

"The artist has an inner eye to see beyond conceptual scaffolding to essentials. His art *was* central in life affirmation — but this oneness of life and art is missed today. Now art is separate — we have isolated the creative man."

Today we have shrunk ourselves with the hugeness of our cities — we are having a crisis of scale. We have lost a sense of intimacy, of being at home. "We have eaten more than we can digest . . . There is a frantic effort to apply the limited vision of the past to a rapidly expanding technological present." An example is the Los Angeles scene — "where people are racing in their little steel caskets without knowing where they are going." Selfishness has created a world where men cannot live to the fullness of their capacity, he said.

"We must find new guidance principles. We're plagued by a lack of balance between man and the environment; we violently oscillate from one solution to another."

Many sensitive people have identified with the artist's images of confusion, fear, insecurity, and the inability to cope with reality, expressed in realistic images (like Edvard Munch's *The Scream*) as well as abstract works. Mondrian was looking for a visual bridge between his internal experience and the world around him.

"Amid the corrosive impact of crowding, air pollution, sound pollution, sensory deprivation — in spite of this murder — still artists could portray what was missing. Turner, the great English master, tried to bring back the lost paradise, with color, light, and space, fused in climactic unity." But he was criticized because his images were undefined. He responded that his indistinctness was his forte — and this is true, said Professor Kepes. "There is an inner core of experience that will fade if you try to define it with clear boundaries."

"To define is to kill; to suggest is to create." If one takes the sentence "I love you," how can you define each word within a boundary? "This is the territory that art gives to us," he explained. "If you try to get too close, try to put details into the total structure, you miss something. (Some people mistakenly study art as if they were trying to understand an elephant through a microscope.)" Flaubert said "the story of the plot of a novel is not of interest — I try to render a shade, a tone, to show the hidden insight process which can be concrete, but all-embracing."

Professor Kepes made a plea for a new role in art: to emerge from the art world into the real world — "into the streets of villages, the backs of streetcars. Let colors be thrown like hues of the rainbow, exalting the common eye. Bring back colors to the world," he emphasized, "create a colorful path of daily routine." Let us have art not just as decoration, but representing community action to recognize the streets as the shared property of everyone. "Our real task is not just to paint beauty in the shadows, but to make the shadows into light," he said. Examples: ghetto houses painted with brilliant colors; the Mexican dance — not just an individual dance, but most importantly a common dance.

We must try to regain this community spirit; to find a method to structure the complexity of our surroundings in our cities; to make new landmarks; to create an orchestration of urban areas, so one can orient oneself. For example — light landmarks in the middle of the city, giving extra joy and richness to inhabitants. Artist Rockne Krebs (*see January, 1976, p. 82*) uses the light from lasers, not as a miniscule toy of the gallery but to be enjoyed in a new kind of environmental unit. It is an attempt to tie together the individual and his limited world with the cosmic scale. "In Utopia," said Professor Kepes, "we would use the creative imagination to mold our environment."

Man's highest reward is in finding his identity, Professor Kepes concluded. "To me art is a means of stirring the greatest number of men with the common joys and woes. We must force the artist out of isolation — he often can best express his resemblance to the community from which he cannot tear himself . . . We have to recognize the meaning of the total community of man. In the final reckoning, we live our lives in individual experience. We all work, dream, love — and on rare occasions we feel a single climactic glow when these experiences are unified in universal understanding." — *M.L.*

"A Shadowy Landscape of Other-Worldliness. . ."

"Transparent Horizon" was conceived by Louise Nevelson to interact with its surroundings. As a commanding presence comparable to Alexander Calder's "The Great Sail," now a landmark at M.I.T., the sculpture will attract visual attention from many vantage points in the area. Nevelson has always been interested in the concept of a total environment, and in devising works for public spaces her holistic sensibility is fully realized.

Successfully capturing in a giant steel translation the enigmatic romanticism she has forfeited in many of her public commissions of the last few years, Nevelson's newest sculpture stands out as the quintessential statement of her later style.

Ultimately, "Transparent Horizon" represents a monumental fragment of Nevelson's private universe. Tenuous associations with commonly recognized reality — plant forms and the vocabulary of architectural parts — are restructured to present a shadowy landscape of other-worldliness, a vision of a haunting mystery. Nevelson focuses attention on the overall experience of the work rather than its separate elements by covering the entire surface with black paint.

Nevelson has been using metal for the last ten years. As with her earlier wood constructions, she makes no sketches but develops ideas by spontaneously composing and combining various elements. She works closely with metal craftsmen at Lippincott, Inc., a factory devoted exclusively to the fabrication of large-scale sculpture.

It was Nevelson's body of works in wood of the mid-1950s, culminating in the great environmental "Dawn's Wedding-Feast" exhibited at the Museum of Modern Art in 1959, that firmly established her critical acclaim. Developing in a constructivist tradition and well-schooled in prevailing Cubist principles, Nevelson emerged in the early 1950s as one of the first artists to transform aggressive surrealist imagery into a more subtle, nostalgic dream world fantasy. By incorporating bits and pieces of objects gathered in her neighborhood into various arrangements — at first on a single base and then in shallow, box-like compartments uniformly painted a matt black (and in some instances white or gold) — Nevelson developed a singular manner and an artistic preeminence in America equalled only by Alexander Calder and David Smith. — *William T. Struble*

A Game to Show Connectedness

Weary of Monopoly, and the tarnished gloss of Boardwalk and Park Place? Then try REDEV, the Maine Regional Development Game devised by a seminar of M.I.T. students.

The idea was to give life, in a game format, to the way the decisions and actions of citizens, legislators, and industry affect development and the quality of life. What happens to a neighboring village when pollution controls force the shutdown of a paper mill in an industrial center? To a quaint seaport when the state Tourist Development Office puts its picture in 2 million national magazines? When a condominium housing development attracts weekend homeowners to a woodsy rural lake?

Hard issues for state of Maine policymakers these days — hard, too, for students in the M.I.T. "system engineering" seminar trying to understand the regional problems of coastal Maine. Everything seemed to them to be connected to everything else, and so they sought a way to simplify and understand the interconnectedness of decisions. If such a way could be devised it would help them — and it might also help citizens and their lawmakers.

Their proposal — a game called REDEV — is shown in the report of the semester-long interdisciplinary system engineering project supervised by William W. Seifert, Professor of Civil Engineeering; the report, "Modeling and Gaming for Regional Planning," edited by Charles Kaminsky, is a publication of the M.I.T. Sea Grant Program.

Imagine Port City, Maine, a coastal city of 60,000 with a good, underutilized harbor and a slowly declining population and prosperity. Twenty miles away is Inlandton, a country village of 3,000; and 30 miles down the seashore is Coastalville, a picturesque fishing village of 2,500. Think — as the students did — of Portland, Gray, and Machiasport.

Now examine a set of 11 social indicators for each of these places — education, medical care, business activity, quality of life, environment, government effectiveness, employment, transportation, recreation, crime, and population.

To play the game requires eight or more players. One is designated as controller, three as social evaluators; the rest of the players are businesspeople (at least two, one of whom represents the industrial interests of Port City) and legislators (at least two, one of whom is elected from Port City and the other from its environs).

As the game begins, all players agree on the starting level of each of the 11 indicators on a scale between 0 and 100. For example, 15 per cent unemployment is 0 for the employment indicator; the cleanliness of Coastaltown's harbor (the kids swim in it every day all summer) earns it a 90 for environment. Then they join to set goals for the social indicators by the end of the first round of play (a goal might be to increase employment to 92 per cent, perhaps 50 on the employment scale). And then each player retires to plot his strategies for meeting the goals with which he is concerned. Inlandton's legislator, for example, decides to build low-cost housing for the elderly in Inlandton; to advertise for tourists to come to Inlandton and Coastalville; and to improve the road between those two points; Port City's businesspeople establish a restaurant-motel-theater complex, trucking company, and soft-drink bottling plant in Port City, and they begin a study of aquaculture.

These decisions reached, the legislators and businesspeople retire while the social evaluators study what will be the effect of these on the 11 social indicators in a five-year period. Like the "penalty" cards in Monopoly, REDEV has a set of "exogenous event" cards, and the social evaluators have to draw on these before they complete their analysis. One reads "strict enforcement of new air and water pollution laws," another "floodwater damage to business and municipal facilities," a third "federal funds available for historic restoration."

Round two of the game begins when the social evaluators return with their report on what has happened to the 11 social indicators in the five years of round one. The process of goal-setting, hypothesizing, and analyzing begins anew for a second five-year period. A game normally includes five rounds of play — 25 years of history.

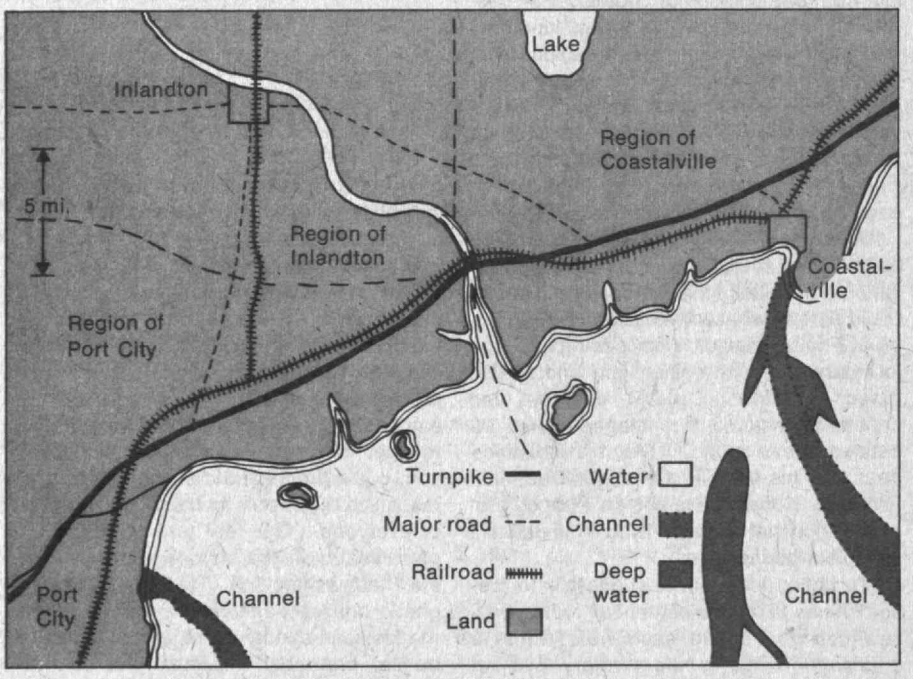
When the M.I.T. students played their game, Port City did well enough. Most social indicators were made to rise, some of them spectacularly. There was fairly good news for Inlandton; conditions there were worse than in Port City when the game started, and they were worse — but comparatively less so — when the game ended.

But the 25-year program was almost nothing but bad news for Coastalville. A new oil terminal came to town, so the business index was up; unemployment dropped, transportation improved, population increased. But there was serious trouble: Quality of life and environmental indicators fell markedly; crime increased; medical care dropped almost to the critical level. The social indicators for Coastalville were 421 points below the goals and 12 points below where they started.

Not realistic, you say? Quality of life and environmental indicators set too high? Try the game again, with different settings and a different scenario. You'll learn still more about how everything interacts with everything else — even in the fastness of Down East Maine. — *J.M.*

Solar Study Near M.I.T.?

A greater Boston location for the U.S. Solar Energy Research Institute — the site will be chosen sometime this spring on the basis of proposals now being submitted to the U.S. Energy Research and Development Administration — would mean "mutually



What happens to Port City, Inlandton, and Coastalville in the five years after a major oil terminal is built at the edge of Coastalville's picturesque Down East harbor? Trying to answer such questions, students in an M.I.T. system engineering class discovered that everything is connected to everything else. They devised a Monopoly-like game, called REDEV, to help understand the complex interrelationships among a set of 11 social indicators.

beneficial interaction" between M.I.T. and the new Institute.

That means joint symposia, adjunct professorships for Institute staff, theses jointly supervised by M.I.T. and Institute staff, and M.I.T. libraries, computers, and specialized equipment available to the Institute, says Thomas F. Jones, Vice President for Research.

The proposed Solar Energy Research Institute will have an annual budget of some $50 million and a professional staff of over 600. It's a big prize, intensely sought by chambers of commerce throughout the U.S. Dr. Jones' statement of M.I.T.'s interest was made to the New England Council, the Massachusetts Science and Technology Foundation, and the Massachusetts Commissioner of Commerce and Development.

Dr. Jones cited — in addition to facilities and intellectual environment — M.I.T.'s specific commitment to solar energy research; it's a three-pronged plan, Dr. Jones said, including fundamental research on solar physics and solar energy conversion as well as development efforts on near-future conversion systems. □

Seamans on Solar Energy

Where should the Energy Research and Development Administration (E.R.D.A.) put its new Solar Energy Research Institute?

Robert C. Seamans, Jr., Sc.D.'51, E.R.D.A. Administrator, has not yet made up his mind. "The important thing," he told Robert P. Hudock, '60, National Affairs Editor of *Astronautics and Aeronautics* in an interview late in the fall, "is that there be the right intellectual climate to engage highly professional people.

"It doesn't necessarily have to be in a part of the country that has the most sunlight," Dr. Seamans said; but he thinks it ought to be "reasonably close" to the field work. That comment was good news for New England's effort to lure the new E.R.D.A. facility, Mr. Hudock thought; he noted that New England now has no major E.R.D.A. facility, that it suffers from high energy cost, and that the region "has considerable political clout."

How will the new Institute be organized? Dr. Seamans' mind is still open on that, just as it is on the location. It could be a fully-controlled government operation, he told Mr. Hudock; or it could be developed in the image of the national laboratories — Argonne, Brookhaven, or Oak Ridge — where universities or industry have management responsibility.

Even though E.R.D.A. is committed to the Solar Energy Research Institute, Dr. Seamans is not even sure just how far the agency should go in that field. Solar energy research is also included in programs of the National Science Foundation and N.A.S.A., and he wants all these programs to cooperate, not compete, Dr. Seamans told Mr. Hudock.

Lillian Hellman, Arthur Kopit: Past and Present

Lillian Hellman and Arthur Kopit, American playwrights, visited M.I.T. last fall. Both were preoccupied with history — Ms. Hellman with simply the fact of it, and Mr. Kopit with how an artist can deal with it.

Ms. Hellman had just completed *Scoundrel Time,* a memoir of her experiences during the McCarthy investigations. And her three conversations with M.I.T. audiences were for the most part reminiscences of her years in the New York theater as playwright and director, in Hollywood as screenwriter, and as an intellectual living in exciting times and moving among interesting people. Looking backward was perhaps inevitable given Ms. Hellman's 70 years, her audience's youth, and her distinguished career — she is author of a number of plays including *The Children's Hour, The Little Foxes, Toys in the Attic,* and two memoirs, *An Unfinished Woman* and *Pentimento.*

The playwright declined to lecture, opening the sessions to questions from the floor. Although the talks were often diffuse and repetitive as a result, they enabled capacity crowds to glimpse something of the lady's wit and temper. She spared neither.

Asked what she thought of the current generation of college students, Ms. Hellman responded, "You don't seem as vigorous as you might be, or as interested in your country. I'm a little disappointed in you. But it may be that students in the sixties weren't all that committed either: their interest flagged quickly enough. Perhaps the peace movement sprang from a desire just to get out of the draft, to avoid Viet Nam." She stared at her questioner. "How old are *you*?" "I was in school in the sixties," he replied, grinning with the realization that he was trapped either way.

Ms. Hellman continued, "It seems to me sad when people become too involved with themselves. I've never known what that word, 'lost,' meant. We're all lost. Why one generation more than another? Wouldn't it be pretentious to describe oneself as 'found' spiritually?

"One shouldn't think things are worse now than in the past. Every generation has problems. The main thing is to have a nice time. If you choose to go on with your life, you might as well enjoy it." Pause. "Get as drunk as you can."

At the same time, by even her own estimate, Ms. Hellman's a bit of a Puritan. "Work is very important. If you work hard enough, you learn to have a pleasant time both when you're not working and when you are."

The playwright distinguished herself during the McCarthy hearings as one of few who refused to testify. Ms. Hellman told the committee, ". . . to hurt innocent people whom I knew many years ago in order to save myself is, to me, inhuman and indecent and dishonorable. I cannot and will not cut my conscience to fit this year's fashion . . ." She says she was able to write *Scoundrel Time* only after giving up a controlled, historical perspective and allowing her anger and fear to surface.

The Feel of History

Arthur Kopit addresses himself to a more distant American past in his plays *Indians* and *Lewis and Clarke.* To give that past presence, Mr. Kopit is experimenting with new ways to write and present plays. In November, he met with M.I.T. students interested in the problems of writing historical dramas and discussed his work.

Mr. Kopit has eschewed the conventional proscenium and finished script for a looser mode in which actor, writer, and audience must collaborate. Scenes dissolve when actors, or audience, tire of them; the set is extremely spare so that a box, for instance, becomes a chair, a mountain, a table; mood rather than story takes precedence.

Mr. Kopit's latest play, *Lewis and Clarke,* was presented on a playing field at Wesleyan College last summer and will move to Hartford, Conn., this year. Neither lighting nor special effects are used to help the actors adjust to an unfamiliar space, and without walls, there is no offstage safety. The audience is unprotected, as well, invited throughout the play to shed one mask for another and become part of the illusion they observe.

One student asked how such a production might differ from the rather tiresome plays of the sixties that not only included but also reviled audiences, determined to offend theatrical tradition and bourgeois sensibility.

Mr. Kopit replied, "What I wanted to create in *Lewis and Clarke* was the feel of history — a theatrical equivalent for audience and actors of historical, geographical exploration, but *without* intimidation. The audience is allowed to maintain its anonymity, but at the same time is offered a sense of thrill, of imminent possibility. We don't destroy the artifice of performance; we acknowledge it by breaking spells and casting new ones, by moving in character and, at the drop of a hat, stepping out of it.

"The underlying aesthetic of this mode is that it's all empirical," Mr. Kopit concluded. "You don't know until you try." — *D.McG.*

Students

Shakespeare Ensemble — Each Performance Grows Beyond the Last

Shakespeare is often mistakenly identified as "abstract and inaccessible." "But after our performance, people said they hadn't realized that Shakespeare was that funny," said Alexey Orlovsky, '77, who played Antonio in the M.I.T. Shakespeare Ensemble's production of the *Merchant of Venice* last fall. To convey Shakespeare's rich humanism dramatically was precisely the goal of the Ensemble when in the fall of 1974 it became the first group in Boston devoted entirely to performing Shakespeare's plays.

But in making Shakespeare accessible, the group hasn't thrown aside the classical cloak. The fidelity to language, verse, and the traditional Elizabethan songs that preceded the play was augmented by the authenticity of the Elizabethan "thrust" stage. That stage places all the performers within 60 feet of their audience — a kind of intimacy which must emphasize acting.

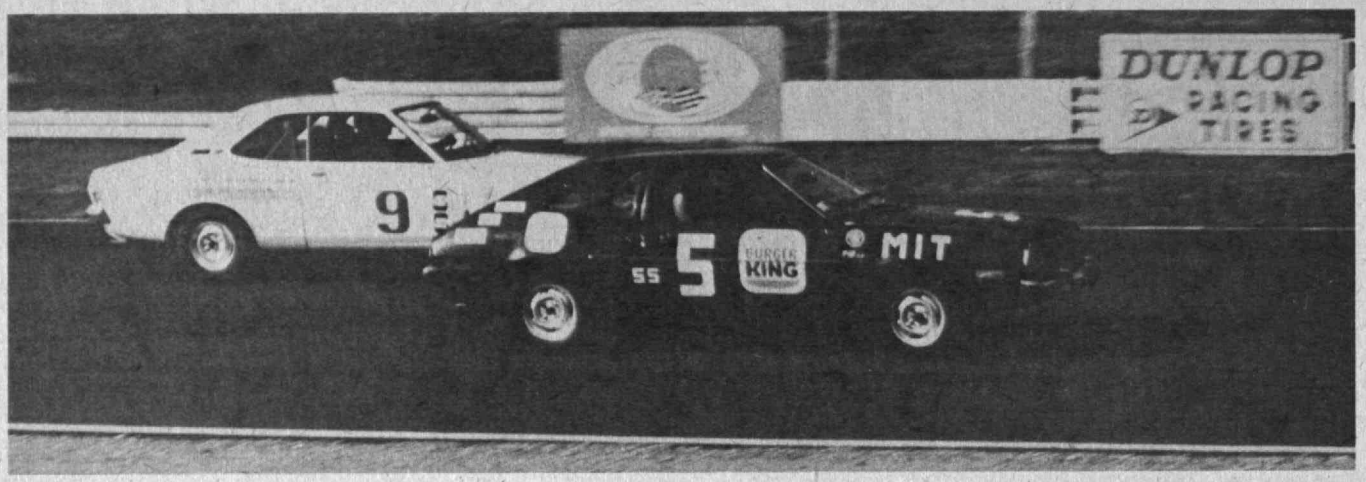
And acting is the main reason these students want to perform Shakespeare. "It's the most intensive form of drama available, the source for other theater," Alexey explained. "There are unique demands on the actors — long soliloquys about feelings, the need to perfect body movement which integrates action with words."

There is comprehensive instruction to meet these demands — movement sessions, voice training, mime. The work toward the final production — there are two major ones a year — is a long process of forging more competent, versatile actors.

Pocket Repertoire, a composite of different scenes performed around Boston, is a way to solve problems before the major production. The actors switch roles and see each other's interpretation of a character so each performance can grow beyond the last. Jesse Abraham, '77, who made believable the two-dimensional Prince of Morocco in *Merchant,* said that he enjoyed playing characters he had never played before. "It's different from one-act plays where you don't have a chance to get into a character. They're more improvisational."

The formalism and seriousness of the Ensemble stems from the superb direction of the group's taskmaster, Murray Biggs, Assistant Professor of Humanities. Said Jesse Abraham, "Murray is a precise director. He tells you what he wants and will say the lines exactly as he wants the character portrayed." — *S.F.*

The conflicts of legality and love came alive through the production of the Merchant of Venice *by the M.I.T. Shakespeare Ensemble last fall. "People — not actors — enter the space we watch. They speak, they argue, they plead, lie, bargain, behave; not as though these things were happening, but better: they* are *happening," praised Mark Fishman of* The Tech. *And their next major production —* Henry IV, Part I *— on February 25 through 29 should prove to be as good. (Photos: bottom left, opposite page, and bottom, this page: Daniel F. Lam; others: Thomas F. Klimowicz, '77)*



The M.I.T. Auto Club: Thrice Champions in Its Second Year of Racing

David A. Schaller, '78

How would I describe what it's like to be part of the M.I.T. Auto Club? In reality I never could, since it is something that has to be experienced. Words cannot describe the feelng when "your" car has battled its way to a well-deserved first place, or when you come upon a check-point during a rally and realize that you are right on time.

It is this common experience that draws the club members together, but these same experiences prevent me from giving you any more than a hint of what the club is really all about.

It was back in 1953 when an M.I.T. club called the Motor Sports Enthusiasts thought about competing in sports car racing. Twenty years later, when reorganized from what had become the M.I.T. Sports Car Club into the M.I.T. Auto Club, the idea finally became a reality, and the oldest college auto club in the country headed for the track.

The purpose of the Auto Club is twofold: to organize a sports car racing team, and to provide help for those aspiring to become involved in racing.

Since the Sports Car Club of America (S.C.C.A.) requires that all drivers have racing licenses, obtained by attending two drivers' schools, going to driving school is the first step in becoming a driver. Dave Ziegelheim, '75, already had his license, so Joel Bradley, Steve Cairns, Ed Mroz, '73, and Gordon Medenica went to the Bill Scott Racing School in Virginia for the first of the two drivers' schools. They returned enthusiastic: the classes were small enough so each had lots of supervision and many chances to drive the school's race-prepared cars.

The next effort of the Auto Club was to seek enough sponsorship to field a car in professional racing. As the members soon found out, even with a winning record money is hard to find; and the $50,000 required to run a professional car proved impossible to obtain.

So Joel and Dave decided to race in S.C.C.A.'s Showroom Stock Sedan (S.S.S.) class, using 1973 Pintos. S.S.S. racing is just what the name implies — sedans which are unmodified (showroom stock), except for required safety features, which include an approved roll bar, fire extinguisher, and competition seatbelt with shoulder harness.

Premiere at Lime Rock

In June, 1973, the Auto Club journeyed out to Thompson, Conn. It was Joel's first race; he was elated with his fourth-place finish, and he proved it was no fluke by finishing second the next week.

During July and August, 1973, the Auto Club ran in several races, never finishing worse than second. This string of fine performances peaked at the Labor Day Nationals at Bryar Motorsport Park, N.H., where Joel took the overall win after setting a new track record of 1:34.8 during qualifying, a full second faster than the old lap record.

The Auto Club returned to Bryar on October 7, looking for a second win in a row. With ideal temperatures, Joel quickly built a three-second lead at the start of the race, setting another track record of 1:34.0 in the process — an average speed of 61.3 m.p.h. around the tight 1.6-mile track. However, bad luck struck the M.I.T. Club, as first Dave's Pinto lost its tailpipe and he was forced to retire and then a few laps later Joel's left front tire failed. While Joel nursed his car around the track toward the finish, he was passed by three cars and ended in fourth place.

The big race each year is the semi-official championship held by *Car and Driver* Magazine at Lime Rock Park, Conn. In qualifying, Joel Bradley turned a lap of 1:15.2, which was fast enough for second place on the 35-car grid. Despite tire problems, Dave Ziegelheim drove the qualifying in 1:17.6, putting his M.I.T. Pinto 27th at the start. A bent wheel ended Joel's chances by sending him out of the race on the third lap. After a run toward the front of the pack, Dave was forced to pit and change a tire, but despite the fast work of the pit crew (Rick Carley, '76, Nat Rudd, '73, and Steve Cairns), the untimely stop cost three laps. After returning to the race, Dave worked his way through the field; but the checkered flag fell too soon for him, and he finished the race in 23rd place.

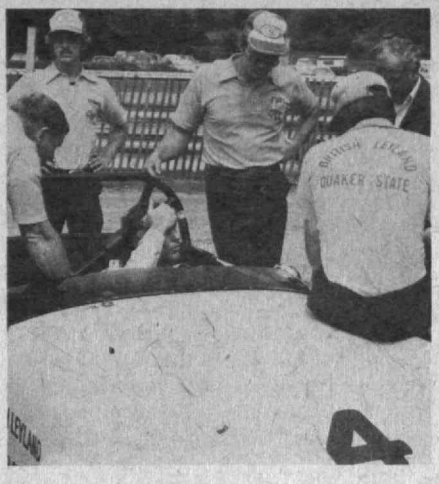
Thus the first year of competition ended with the M.I.T. Auto Club winning the New England Intercollegiate Championship (a new trophy started by the S.C.C.A.), holding the lap records at Thompson and Bryar, and starting from the pole position in five races.

1974: Three Championships

The success of the Auto Club in its first year helped win sponsorship for the 1974 season, when Burger King Corp. agreed to provide funds to meet costs, Atamian Ford to sell parts for the Pintos at cost, and Semperit to sell tires at half cost through their New England distributor.

The season began at Lime Rock, and the opener was M.I.T.'s best race of the regular season. In qualifying on Saturday, Joel posted the second fastest time, and Dave was third fastest. However, Joel's Pinto was hit by a novice driver, and Dave's car lost a muffler, giving the pit crew (Steve Cairns, Ed Gardner, '75, Gunnar Gangasaas, '74, Lynn Davison, '75, and Bob Humphrey, '77) a tough job to put everything back in racing order.

At the start of the race, Joel dropped four seconds behind Paul Hacker's Dodge Colt as he avoided a spinning car. Joel then started reeling in the Colt and inched past it down the straight on lap six. On lap seven, Dave was hit and sent spinning by another car, and he quickly found himself a lap down. Hacker managed to slip his car past Joel on the straight in lap eight, and for the next three laps Joel looked for a way around him. Finding his chance when they came upon a slower car, Joel squeezed by Hacker into the lead. On lap 13, Paul pulled alongside Joel on the straight, and, door-to-door, the two cars swept through the S-curves, neither driver giving an inch. Hacker pulled ahead on the back of the course, but Joel took the best line coming out of the diving right-hand corner that exited onto the straight and regained the lead. The final two laps drew the spectators to their feet as Joel held Hacker off, outbraking him into the big bend at the end of the straight and then holding his line through the S-curves. In a



The M.I.T. Auto Club opened the 1974 season with Joel Bradley, a graduate student in electrical engineering, driving his Pinto to what David A. Schaller, '78, calls the "Club's most exciting victory (opposite). The other pictures demonstrate the pressure and fun which Mr. Schaller finds he cannot put into words: John L. Kelly, '56, with his team after finishing second in his MG Midget at Lime Rock in August, 1975 (left), and Stephen W. Cairns celebrating with champagne after winning another Lime Rock race during the same weekend. (Photos: Richard F. Reihl, '78, and David A. Schaller, '78)

last-ditch effort to gain the lead on the final lap, Hacker tried to pass on the outside of the diving turn, but he went wide, allowing Joel to take the M.I.T. Auto Club's most exciting victory.

In July, 1974, at Thompson, the Auto Club had three drivers; Steve Cairns had just received his license and was driving a 1973 Opel. Joel took first place in both races, setting another new track record, and Steve scored a second and a third.

The next race was at Lime Rock, where Joel again picked up two first-place finishes. Joe extended his winning streak to five on September 8 to 9, when he qualified on the pole and then led all 20 laps of Sunday's race. In Monday's race, Joel again was fastest, leading the race, but he was forced to retire with mechanical problems. Steve showed his talent by finishing second in both races, as well as driving the fastest lap in Sunday's race.

The final regular-season race in 1974 at Bryar again went to the M.I.T./Burger King Pinto of Joel Bradley — but not without a challenge from Steve, who finished second and set a new track record while trying to catch Joel.

A total of 65 cars showed up for the 1974 *Car and Driver* Challenge, but only 32 made it to the final race. All three M.I.T. cars were in the final, with Joel taking the pole position. Steve and Dave were gridded fifth and sixteenth respectively. But it was not to be another pole-to-pole win for Joel; as he came out of the diving turn on the third lap, still in the lead, he was passed by two cars piloted by experienced drivers from outside New England. Joel had no problem maintaining third place for the rest of the race, while Dave worked up to tenth spot and Steve, after taking an off-road trip to avoid several spinning cars, worked his way back up to eighth position.

What a year! After just one season of experience, the M.I.T. Auto Club held the New England Intercollegiate Championship for the second year in a row, won the New England Road Racing Championship, and won the North Atlantic Road Racing Championship; and Joel Bradley qualified on the pole for the *Car and Driver* Challenge, finishing third ahead of 64 other entrants from across the country.

From Race to Rally and Drag

1975 proved to be a disaster. Steve Cairns left the team to go on his own. We failed in our attempts to locate sponsorship. Dave bought a new '74 Opel and then found out that it had bugs in the front suspension which turned out to be a problem for the whole year. Joel crashed at Lime Rock during practice for the first race of the year and then decided that his thesis was more important than repairing his car. The Auto Club went winless in the racing department.

This proved a blessing in disguise, however, since it allowed the Auto Club to broaden its base and move into other areas. So it is that Rich Fagin, '78, heads up the recently formed drag racing department, and Road Rallying, the sport of following a set of route instructions while maintaining a prescribed average speed, is the most active department.

Although Rich is the only active drag competitor, several club members are avid spectators. Russ Kao, '77, Jim Muller, Charlie Dudney, John Kowaleski, '76, Terry Blumer, Carl Hayssen, and Bob Humphrey all hope to bring the Auto Club rally wins during the year. The popularity of rallying is easy to understand, since it requires no special equipment — just a car and two people — one driver, one navigator.

Our club meetings have also taken on a new look under the guidance of our president, Bob Humphrey, and in the future will include movies, slide shows, guest speakers, seminars, and Club-sponsored rallies. □

Concourse Forum: Anatomy of Murder, Resurrection, and Riches

The lecture hall is alive with talk and movement. In strides Richard Nixon, arms raised in victory. He trips and takes a seat. The audience bursts into applause. A little later, Groucho Marx oils his way across the floor, cigar dangling and eyebrows a study in perpetual motion. The projectionist has disappeared and a young man grudgingly volunteers his services. The First Annual Halloween Concourse Forum at M.I.T. is about to begin.

Saul Benison, Professor of History and History of Medicine at the University of Cincinnati, has come all the way from Ohio to speak. His topic: "The Sack-em Up Men: A History of Grave Robbing." Dr. Benison advises: "If you get bored, leave. I can't hold it against you since I don't know your names." But his counsel is to no purpose. For over an hour he holds the audience in thrall with tales of body-snatching, murders — and a history of how it all began.

Death lost some of its mystery in the 16th century with the rise of anatomy as a discipline, says Dr. Benison. The laws were slow to respond by lifting the bans on dissection of human corpses, so charnel houses and places of execution became the favorite haunts of eager medical students. The poor and prisoners sentenced to death became the unwilling — and unsung — contributors to science.

By mid-18th century, London and Edinburgh had become the leading educational centers of the discipline with a welter of teaching hospitals and private schools of anatomy. But still the prohibition on human dissection had not been lifted. So in the shadows of the dissecting rooms where hundreds of students and doctors gathered each year hovered an increasing number of "resurrection men." Body-snatchers, that is. And no wonder, according to Dr. Benison. The trade may seem distasteful, but it was very lucrative. A weaver at the time could earn 22 shillings a week. Bodies were worth between £7 and £11. A good set of teeth brought £5.

There was no legal onus. In 1826, a distraught husband complained to a magistrate that his wife's body had been stolen from the bedroom where she lay in state. The magistrate ruled the matter was outside his province. Since the resurrection men had thoughtfully left the woman's personal effects behind, no theft had been committed. Under the law, a body was not a piece of property.

As time passed, the resurrection men became braver. When an eight-foot-tall Irishman named John Burns fell ill, he noticed the chief of a dissecting room loitering outside his house. Terrified, he ordered a lead

coffin and died in peace. Five hundred pounds in assorted pockets later, his body arrived at a school of anatomy. The skeleton remains on display today.

A booming trade soon commenced to serve a frightened public. Barricades, trip guns, and iron wires were purchased to secure graves from disturbance. A Mr. Bridgeman marketed a self-sealing iron coffin and made a tidy sum.

Eventually, the eager resurrection men turned to murder. "That was hardly necessary," Dr. Benison comments. "The industrial revolution of the 19th century brought a number of occupational diseases, and one of the worst was alcoholism. Liquor was produced in abundance to maintain the corn market, and its largest consumers were the country people attracted to cities by the promise of factory work. They died easily enough on their own, but the more intractable prospects could be suffocated without much effort. And without a trace to damn the resurrection men before the law."

Why were the resurrection men so successful? "They preyed upon the poor," says Dr. Benison. "Even in cases of murder, there was most often no protector to complain or protest."

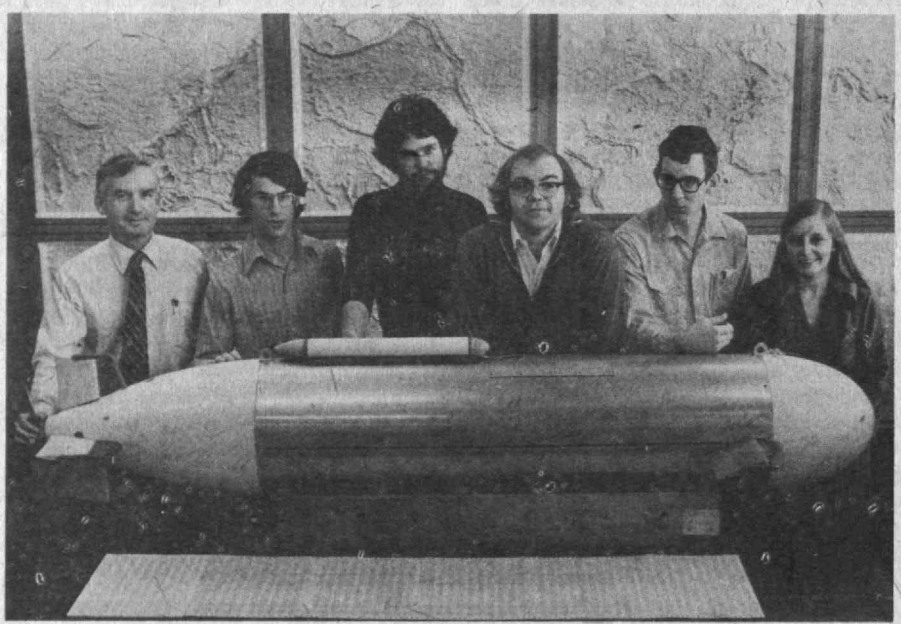
But finally someone did protest. In 1831, an anatomy act was passed that legalized dissection. As bodies became available to anatomists under the law, the murders and body-snatchings ceased. — *D.McG.*

Two Landmarks for Automated Submarine

An eight-foot, 250-pound underwater robot designed by M.I.T. undergraduates has passed two primary tests on the way to effective service in oceanographic research.

The torpedo-shaped submarine, product of student research which began in 1973, was operated under computer control for the first time last summer in Castine, Maine, during a summer laboratory program conducted by the Department of Ocean Engineering. Since then, in a fresh-water lake near Boston, the robot has been put through a series of underwater maneuvers and has performed its first data-collecting mission: water temperature readings at specified depths during a four-minute cruise.

Navigation is controlled by an on-board minicomputer in which were recorded the temperature data during the test run. The next stages of the project call for improving reliability, installing a collision avoidance system, and preparing sonar communications so data can be telemetered from robot to land or a mother ship. □



A special-purpose minicomputer and autopilot have been designed — and now successfully tested — by M.I.T. students in this unmanned underwater oceanographic research vehicle. The automated submarine, a project of many groups of M.I.T. undergraduates beginning in 1973, has now collected water temperature data along a preplanned course in a fresh-water lake near Boston. Eventually up to 50 pounds of measuring instruments, including a movie camera and sonar equipment, will be added. In the picture are Professor A. Douglas Carmichael (left) and five of his students in the Department of Ocean Engineering; in the foreground is a print-out showing water temperatures and depths recorded by the submarine's computer during its first excursion last fall.

Fellowship and friendship were both evident when Dr. and Mrs. Cecil H. Green met the 1975-76 Green Fellows early this year. Left to right: Kathleen D. McFadden, Mrs. Green, Alice Cantelow, Marta E. Greenberg, Marjorie A. Flavin, Joanne Higgins, Patricia Bjorklund, Dr. Green (he is a member of the Class of 1923), Carolyn M. Gee, and Jennifer Gordon, '75. The Green Fellowships were established in 1974 by a $1-million gift to provide support primarily for women in the M.I.T. Graduate School. What better reward for $1 million? (Photo: Calvin Campbell)

The Pressure of Unvoiced Assumptions

Jennie Patrick

The number of minority students at M.I.T. has increased. But statistics are an impersonal gauge of changing times. What does an individual minority student feel when confronted with M.I.T.'s frenetic atmosphere plus personal social adjustment problems?

Jennie Patrick, a black Ph.D. candidate in chemical engineering answered:

"I would be a fool to forget who and what I am, and to think I can come to M.I.T. and deal with it as a white student does; whites are perceived in a different manner. How M.I.T. reacts to them is very different from how M.I.T. reacts to me. They have different problems and in many ways less pressure than I have. If I think I can overrule all these negative things and be on the same scale, then I'm being naïve.

"There are those individuals who try to impose upon me the desire to prove myself; but I refuse to engage in such a demeaning life style." Examples? "I walk into class and happen to be the T.A.; students are shocked. I can tell by facial expressions and comments. They did not expect to see me — whether it is because I'm a woman or because I'm black or both. Questions tend to have a negative connotation, says Ms. Patrick: "How were you able to make it? (implying they expected or hoped otherwise). I'm asked if my parents were educated or middle class (they were not). It's presumed I went to prep school (I didn't). I'm a graduate student; it's assumed for a Master's.

"I don't think it's basically academic problems disturbing black students competing with whites; rather its social and racial problems. Many individuals can't function under pressure or isolation. Living in the dorm, you see eight or ten white students working on homework solutions together. They make an effort to have study groups and they have access to old homework. My first attempt when I came here was to become part of a group — and I found that was more devastating than having to do homework alone. A great part of the learning experience is to be able to express ideas to other people through discussion. If you have to go through a silent thought pattern, you don't get that benefit — the amount of time you have to spend may be doubled. They will *invite* a white person to join the group, but a black has to be aggressive and ask to join. And then when you get there, the whole atmosphere changes. (They were always reminding me of my race.) There tend to be a few people in the group who are open-minded; it has not occurred to them that others in the group are chary of accepting a black presence or input.

"My attitude is not to be concerned with what *others* expect. I do feel the need to fulfill my own desire to learn. Basically, as long as I'm doing work satisfactory to me, there cannot be an honest question of the work quality because of the high standards I've set for myself."

Ms. Patrick feels that the media emphasize negative, not positive, things about minority students and people in general. The attitude toward black students is that they lack qualifications. "If a black student can't cope, it's easier to say the individual is stupid than to understand the problem and its source.

"White students can turn to a large cadre of white faculty members and classmates for support: tutorial help, social activities, financial aid, and encouragement. So programs such as 'Interphase' [*see October/November, 1975, p. 88*] and the Black Student Union tutorial program are very helpful to black students, filling a void created by racial and social isolationism."

Ms. Patrick says she is outgoing — a trait needed for survival. "It is necessary for me to express my feelings or I would be troubled. If a person puts the burden of prejudice on me, I think I should share it with him — so he can go home and think about it. Why should I suffer while he or she goes scot-free?" — *M.L.*

Women Rejoice: The "Mary Hemenway" Arrives

For the first time ever, the M.I.T. fleet includes an eight-oared shell especially designed and designated for women.

She's the "Mary Hemenway," and her arrival at the Pierce Boathouse represents a significant gain for women's athletics at the Institute, think Professor Mary-Lou Sayles, athletic director.

That's the donor's intention, too. Mary Hemenway was one of the pioneer proponents of athletics for women in a pre-Victorian era when only men were supposed to have the pleasures and benefits of competitive sports; the Hemenway Gymnasium at Radcliffe also celebrates her enthusiasm for women's athletics. The original Mary Hemenway's granddaughter is the donor: Mrs. Mary Homans of Milton, Mass. No coincidence that Mrs. Homan's granddaughter is Roseanna Means, '76, an enthusiastic member of M.I.T.'s varsity women's crew; she's majoring in biochemistry and hopes to attend medical school next year.

Though the "Mary Hemenway" was christened in informal ceremonies on Class Day (November 8), she had already felt the pressure of competition on the Charles. The M.I.T. varsity women's crew were among 2,870 competitors entering the annual "Head of the Charles" Regatta on October 26; though this year's varsity crew rowing the "Mary Hemenway" failed to place in the top ten women's eights, they significantly bettered their time of a year ago in the same race. Miss Means gives the credit to the "Mary Hemenway" — "she's a lovely boat!" □

Mary Homans' grandmother was a pioneer proponent of athletics for women; her granddaughter, Roseanna Means, '76, is a member of the M.I.T. women's crew. Now Mrs. Homans has given M.I.T. its first eight-oared shell designed for women.

Gregory M. Saltzman, '76 . . .

. . . and Gwen Champion, '76 (with friend, above) agree that people in London "seemed friendlier" than at M.I.T.; they both liked their junior years abroad.

Why Study in London? It's a Different World

Gwen Champion, '76, and Gregory M. Saltzman, '76, spent their junior year in London. They feel it was a valuable — and different — learning experience.

The first thing Greg Saltzman noticed at the London School of Economics was no problem sets, no quizzes. There was one exam at the end of the year in each subject. "The result was almost no pressure during the year (when students don't work as hard as they do here). But in the last three weeks you really sweat." M.I.T.'s rigid structure of assigning one textbook and expecting a mastery of its material contrasts sharply with the London School of Economics' policy. There an instructor would give you a reading list of 40 books, said Mr. Saltzman, and you read what you found interesting. "You don't have to learn one narrow field extremely well; you just have to be able to write intelligently about the field in general," he explained. He speculates that this may characterize a social science school. "Some of the rigidity in the education at M.I.T. may be inherent in a science education."

Increased free time wasn't wasted. "I learned less classroom economics there than here, but I learned much more of other things. And I now appreciate the value of leisure time," he said. "Spending hours arguing with Trotskyites and Stalinists (the London School of Economics is a hotbed of radical activists, always interested in arguing with a 'running dog of capitalism'), I got a clearer idea of my own values. I neglected this at M.I.T."

"Here, I would be left of center. There, I was a hard-core reactionary. The general secretary of the student union was a card-carrying member of the British communist party. I could understand if he were a Maoist, Ché Guevara follower, but he was a Stalinist — and there are lots of people like him. There McGovern would be considered a reactionary because he is not a socialist. When students invited some conservative party members of Parliament to speak, the turnout was disappointing. But when Bernadette Devlin came to raise money, she got a large and enthusiastic audience; in the question period, only one was at all critical, and that one was from me.

Students at M.I.T. are not as interested in social and economic issues, he said. "I'm now more interested than I was before in the social implications of the theoretical models I studied at M.I.T. My exposure to people whose viewpoints were very different from mine has made me more conscious of my own assumptions," said Mr. Saltzman.

Gwen Champion went to Imperial College in London to study organic chemistry, and she, too, found that how much she worked "depended on how much effort you wanted to put in," although her schedule was more rigid than Mr. Saltzman's. The grading system was a posted list in order of merit; rarely does the student get the results of an exam. "You never get a paper back," she explained, "The exam is a gauge of how well you're doing for the professor, not a learning experience for you. It is for a private record that no one is to see. And during a lecture, the lecturer is right; the student never questions."

People seemed friendlier than at M.I.T., says Ms. Champion. Perhaps this was because the curriculum is rigid; she saw the 18 people in her class constantly.

"Academically, I learned lab techniques — to know when or how to do an experiment; what to look for, what not to look for; and that is very valuable," she emphasized. — *M.L.*

People

A New View of M.I.T.'s 110 Years

From William Barton Rogers' famed note, "May this not prove a memorable day," as classes began at M.I.T. on February 20, 1865, through announcement of the 1975 Nobel Prize to Dr. David Baltimore last October, highlights and sidelights of the Institute's history are chronicled in a new book, *MIT in Perspective,* by Francis E. Wylie, to be published March 5 by Little, Brown.

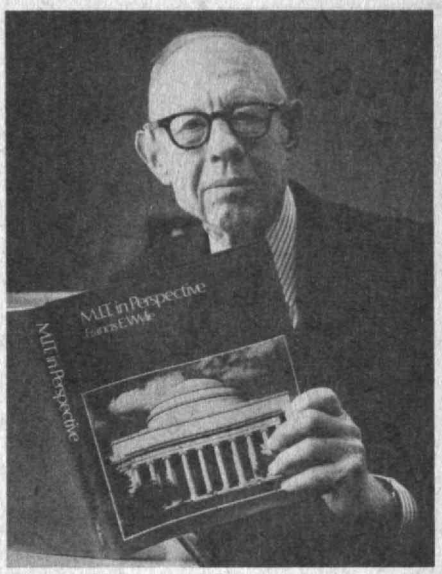
Advanced sale of the book ($15.00) has begun for the M.I.T. community and alumni. Copies are available from the Alumni Association (Room E19-437, M.I.T., Cambridge, Mass., 02139) and at the Tech Coop.

Mr. Wylie retired in 1970 after 15 years as Director of Public Relations at M.I.T. His 207-page book contains 280 drawings and photographs, arranged in chapters which detail moments of significance for the Institute as well as the development of both traditional and modern disciplines.

". . . Rather than attempting to weave stories into a broad, continuous fabric, as a skillful historian would do, I have taken liberties with chronology and, for more or less logical reasons, have manipulated history to provide self-contained sequences," Mr. Wylie wrote in the preface. "One will therefore find 1975 pictures mingled with those of 1875."

Because of the extensive use of pictures, the book is especially appealing as a record of how M.I.T. has changed and grown over the years. The text — some 60,000 lively words — describes not only the great breakthroughs which raised M.I.T. to its position of preeminence in science and technology, but also moments of significance to the Institute itself, such as the great celebration commemorating the move to Cambridge in 1916, the closing of the Radiation Laboratory after World War II, and even student pranks and protests.

President Jerome B. Wiesner, writing in a foreword, says he finds Mr. Wylie's an "exciting . . . panoramic view. . . . This pictorial story of M.I.T. is presented in a manner that is absorbing and contributes very much in its own special way to the comprehension of the Institute's history and character." □



Francis E. Wylie, retired Director of Public Relations, has drawn on his own knowledge of the Institute and the resources of the Historical Collections, Archives, and Technology Review *to complete* M.I.T. in Perspective, *to be published March 5.*

Addresses of over 62,000 alumni are in this new book, and the names of 21,941 deceased alumni. And there are 5,000 "ADUNCS" — address unknown.

90,000 Names in the 1975 Alumni Register

The names of 89,988 M.I.T. alumni are in the 1975 centennial edition of the *M.I.T. Alumni Register* published during the last days of 1975 — more by 15 per cent than in the previous (1966) edition.

Addresses are given for over 62,000; 21,941 alumni are listed as deceased, and just over 5,000 are "ADUNCS" — address unknown.

Information for the new *Register* was collected through 58,000 questionnaires mailed late in 1974; the response was 62 per cent, according to Barbara Durland, Director of Alumni Records. Resulting data constituted an information base used for a computerized information file developed by the Alumni Association during 1975 and for the computer-generated typesetting which now appears in the 1975 *Register*.

Living alumni are listed alphabetically with addresses, by major affiliation — classes for undergraduate alumni and by department or course for graduate alumni, and by place of residence. Deceased alumni are listed alphabetically.

In addition, there are rosters of M.I.T. Presidents, members of the Corporation, and officers, staff, and awardees of the Alumni Association; summaries of alumni population growth and distribution; and a complete list of Courses and degrees offered by M.I.T. since its founding.

Copies of the book are $14.50; and orders should be sent directly to the Alumni Association, Room E19-437, M.I.T., Cambridge, Mass. 02139 □

Four Faculty Take Professorships as M.I.T. Seeks to Remedy "Severe Undercapitalization"

Four appointments of distinguished faculty to endowed professorships, including three new chairs never previously occupied at M.I.T., have focused attention on the $50-million goal for new endowment professorships which is part of the $225 million Leadership Campaign.

The new appointments:

— Professor **Nicholas J. Grant,** Sc.D. '44, Director of the Center for Materials Science and Engineering, is ABEX Professor for Advanced Materials.

— Professor **J. Herbert Hollomon,** '40, Director of the Center for Policy Alternatives, is Japan Steel Industry Professor in the School of Engineering; it is a new chair made possible by a $1 million gift from the Japan Iron and Steel Federation.

— Professor **Jack L. Kerrebrock,** Director of the Department of Aeronautics and Astronautics' Space Propulsion and Gas Turbine Laboratories, is the first Richard Cockburn Maclaurin Professor in Aeronautics and Astronautics.

— Dr. **Robert S. Morison,** formerly Director of Medical and Natural Sciences at the Rockefeller Foundation, is Visiting Professor of the Class of 1949; he is thus the first incumbent of the Class of 1949 Professorship established by the Class and its 25th-year gift to the Institute.

Such appointments to endowed chairs, says a statement prepared by the Leadership Campaign in support of its $50 million goal, "recognize exceptional achievement and outstanding potential." Holders are assured "the means and the incentive to pioneer new directions in teaching and research . . . to move steadily forward in the search for solutions to society's most pressing problems and the unlocking of nature's innermost secrets."

Individual Freedom, Institutional Strength

The new professorships bring to just over 65 the total of such fully-endowed chairs at M.I.T., and achievement of the Leadership Campaign's $50 million goal will result in nearly doubling that number. Several purposes are served:

— An endowed chair is "a living tribute to the achievements and ideals of the individual in whose honor it is established and whose memory it perpetuates."

— An endowed chair "acquires a history and tradition of its own, imparting a heightened sense of purpose and continuity from one holder to the next, . . . an ongoing record of the men and women who have held it and of the contributions to knowledge which it has helped foster."

— An endowed chair "plays a pivotal role in stimulating and influencing the field in which it is designated." This is because its tenant has "utmost freedom" in choosing the problems on which he will work, even using that freedom "to reorient his academic career when this might otherwise be unfeasible."

With fewer than 70 such chairs in a faculty of over 900, M.I.T. is "severely undercapitalized," says the Leadership Campaign statement. Achievement of the $50-million goal thus "will profoundly affect the future quality of the Institute and will help determine the role that M.I.T. plays in meeting the challenges of the next 25 years.

"To maintain its strength, M.I.T. must continue to both recognize and encourage superior performance among its faculty and provide extensive opportunities for creative work and professional development. These needs," says the Leadership Campaign, "are most effectively met through the establishment of endowed chairs." □

Alumni to Hear of Advances in Health, Energy at "Technology Day '76"

M.I.T.'s role in developing new energy resources and in bringing technology to bear on health problems will be the topics of discussion at Alumni Day on Friday, June 4, 1976. This year the annual event has been rechristened "Technology Day."

Participants in the 1976 program will be able to choose either speakers and demonstrations courtesy of M.I.T.'s Energy Laboratory, or lectures and seminars on medical advances from some of the Institute's most prominent life scientists.

In each case morning sessions on June 4 will consist of an overview of current problems and opportunities in energy, or health and medicine. The afternoon program will consist of tours, demonstrations and seminars covering promising research projects currently underway at the Institute.

The Friday afternoon presentation "An Historical Overview of M.I.T. as a National Resource," will feature some of the innovators important to M.I.T.'s development into one of the world's leading technological institutions.

The committee for this year's program: Edward C. Ehrlich, '55, of Tufts New England Medical Center, Professor Jeffrey A. Meldman of the Sloan School of Management and Jamie C. Chapman, Ph.D. '66, of Terrestrial Systems, Inc., Lexington, Mass. — *D.M.*

N. J. Grant

J. H. Hollomon

J. L. Kerrebrock

R. S. Morison

Nicholas J. Grant, Sc.D. '44
ABEX Professor of Advanced Materials

High-temperature metallurgy has been Professor Grant's specialty ever since he received his bachelor's degree from Carnegie Institute of Technology in 1938, and he has been following it at M.I.T. for 35 years. The result is more than 300 technical and scientific papers, a widely-accepted book (with Dr. A. W. Mullendore) on *High-Temperature Materials,* and now the ABEX Professorship in the M.I.T. Department of Materials Science and Engineering.

A member of the faculty since 1945, Professor Grant became Professor of Metallurgy in 1956 and Director of the Center for Materials Science and Engineering in 1968; the Center is an interdisciplinary organization in which members of the Departments of Physics, Materials Science and Engineering, Electrical Engineering, Chemistry, Mechanical Engineering, and Civil Engineering are active; there are extensive programs on surfaces and surface phenomena, materials processing, mechanical behavior of materials, and electronic and optical materials.

The ABEX Professorship was first established in 1955, and it has been renewed ever since by annual grants from the ABEX Corp., New York.

J. Herbert Hollomon, '40
Japan Steel Industry Professor of Engineering

In granting M.I.T. $1 million last fall, the Japan Iron and Steel Foundation said it wanted a professorship devoted to "understanding the complex interactions of technological, social, economic, political, and environmental problems" — an emphasis on "technology and policy," said Yoshihiro Inayama, Chairman of the voluntary, nonprofit trade organization.

The choice of Dr. Hollomon is obvious: a metallurgist by training, he is now deeply engaged in a series of projects on the role of technology in "a wide spectrum of pressing socio-technical problems in government, industry, and education." These include studies of science, technology, and public policy; manufacturing technology and job satisfaction; natural resources; energy policy; communications policy; the delivery of public services; professional manpower supply and utilization; and industrial innovation.

Upon completing his doctorate at M.I.T. (1946), Dr. Hollomon joined General Electric Co., where he was Manager of the General Engineering Laboratory for two years before being called to Washington as Assistant Secretary of Commerce for Science and Technology in 1962. He was President of the University of Oklahoma from 1968 to 1970 and since then has held his present post as Director of the Center for Policy Alternatives and Professor of Engineering at M.I.T.

Jack L. Kerrebrock
Richard Cockburn Maclaurin Professor in Aeronautics and Astronautics

The first contribution to the Maclaurin Professorship came from the late Alice P. Hunsaker, whose husband, Professor Emeritus Jerome C. Hunsaker, Sc.D. '23, is a distinguished pioneer of aeronautical engineering who headed the Department at M.I.T. from 1933 to 1951. Mrs. Hunsaker's purpose was to honor M.I.T.'s sixth President "for his encouragement of emergent fields of science and engineering"; it was during Dr. Maclaurin's leadership of the Institute that M.I.T. gave the country's first graduate course in aeronautical engineering (1914) and the first doctorate in that field (1916).

Aeronautics and astronautics is a far more sophisticated field today, and Professor Kerrebrock's work is partly responsible. He studied at Oregon State (B.S. 1950), Yale (M.S. 1951), and California Institute of Technology (Ph.D. 1956), and he continued at Caltech as Senior Research Fellow until coming to the Institute in 1960. His recent work has been in the field of magnetohydrodynamics with applications to air-breathing propulsion systems and gaseous nuclear rockets. He has also been instrumental in developing a unified undergraduate program for the Department in which the basic disciplines of heat transfer, aerodynamics, and wave propagation are taught as a unified application of science to engineering problems.

Dr. Robert S. Morison
Visiting Professor of the Class of 1949

Dr. Robert S. Morison is one of the most respected figures in the biological sciences, a leader for 20 years in the Rockefeller Foundation's programs in biology, medicine, and public health (these included the development of research and teaching on mental illness, the study of insect-borne virus disease, and the promotion of modern medical education in developing countries), and for ten years in biological science and later public policy of Cornell University.

Now Dr. Morison will continue his work on problems of science and society; as Visiting Professor at M.I.T. he will study ethical problems in medical and life science and the future of the health professions.

It is just what the Class of 1949 had in mind, according to Paul E. Weamer, President, in designating its 25-year gift to endow a professorship; the goal was simply to help the Institute attract outstanding professional people for research and — especially — teaching. That the new appointment strengthens the new and expanding biological-medical field, says Mr. Weamer, "fulfills all the objectives we could hope for."

Dr. Morison studied at Harvard College and Harvard Medical School, and he joined the Rockefeller Foundation after eight years on the staff at Harvard. For six years beginning in 1964 he was Director of the Division of Biological Sciences at Cornell; in 1970 he became Richard J. Schwartz Professor of Science and Society and was thus a founder of the Cornell Program on Science, Technology, and Society.

24 Faculty Visitors

Twenty-four distinguished visitors are joining the M.I.T. faculty on temporary appointments this year:

— **Eytan Barouch** was Assistant Professor of Mathematics at M.I.T. from 1971 to 1974; now he is back (from a post at Clarkson College of Technology) to teach in the Sloan School of Management as Visiting Professor.

— **Adam C. Bell,** Sc.D. '69, Associate Professor of Engineering at the State University of New York (Buffalo), is teaching in the Department of Mechanical Engineering as Visiting Associate Professor; his field is instrumentation and design in dynamic systems.

— **Robert L. Blakeley** has been associated with the recent discovery of the first biological role for the element nickel; he is Senior Lecturer in biochemistry at the University of Queensland, Australia, on leave this year to be Visiting Associate Professor of Chemistry at M.I.T.

— **Glean Chase,** Visiting Associate Professor of Architecture, is spending the year as a commuter between Cambridge and Pratt Institute, where he has been a member of the faculty since 1969. A native of Trinidad, he studied in Israel, England, and New York and is known for his work to bring minority youth and "street people" into architectural careers.

— **Ye T. Chou,** a metallurgist who is now at Lehigh University, is Visiting Professor of Materials Science at M.I.T. for the current year; he holds degrees from Chunking University and Carnegie-Mellon.

— **Geoffrey P. E. Clarkson** was a member of the Sloan School of Management faculty from 1961 to 1965; he is now back as Visiting Professor, on leave from the faculty of the Business School of the University of Manchester, England.

— **Henry Steele Commager,** one of America's most distinguished living historians, is Visiting Professor of History teaching a new undergraduate subject in "Foundations of American Nationalism, 1774-1815." Dr. Commager is Emeritus Professor of History at Amherst College, and his career as a leading writer in American history spans almost 50 years; his work is concerned with both the intellectual and constitutional history of the American republic.

— **Michael R. Davis,** Senior Lecturer at the University of New South Wales, is Visiting Associate Professor in the Department of Ocean Engineering; he is also associated with the Institute of Sound and Vibration Research at Southampton University, where he studied for degrees in aeronautical engineering.

— **Charles G. Gross,** who taught at M.I.T. from 1961 to 1965 before joining the Department of Psychology at Princeton, was back at M.I.T. for the fall term as Visiting Professor of Psychology.

— **Lillian Hellman,** Visiting Professor of Humanities, delivered three lectures at M.I.T. during the fall term on "The Film Experience." Ms. Hellman is widely known as playwright and novelist; her M.I.T. lectures were on her experiences in Hollywood in the 1930s and 1940s completing film adaptations of her three major plays.

— **John R. Hersey,** Lecturer at Yale University, devoted three days a week at M.I.T. during the first term to teach a seminar in fiction writing, "The Writer's Craft." Mr. Hersey is a Pulitzer-Prize-winning novelist and journalist who was associated with the late Sinclair Lewis before achieving wide recognition as a correspondent in World War II.

— **Werner Kanzig,** Professor of Physics at the Swiss Federal Institute of Technology in Zurich, is Visiting Professor of Physics working on the applications of light-scattering phenomena to biophysics in association with an M.I.T. group led by Professor George B. Benedek.

— **Edwin Kessler,** Sc.D. '57, Director of N.O.A.A.'s National Severe Storms Laboratory, Norman, Okla., was Visiting Professor in the Department of Meteorology during the fall term; he is an expert on the occurrence and effects of tornadoes, hurricanes, and other severe weather phenomena.

— **Shan S. Kuo,** Professor of Applied Mathematics and Computer Science at the University of New Hampshire, is Visiting Associate Professor in the Sloan School of Management; he was with M.I.T.'s Computation Center from 1962 to 1966, following academic work at Ohio State, Harvard, and Yale.

— **Christoph Haehling von Lanzenauer,** a member of the University of Western Ontario faculty, is Visiting Associate Professor in the Sloan School of Management. A native of Germany, he has specialized in the study of European management institutions.

— **John R. Moroney,** whose special field is economic theory applied to international trade and money and industrial organization, is Visiting Professor of Economics; he is on leave from Tulane University, where he has taught since 1972.

— **Daniel E. Munick,** Ph.D. '66, has been engaged in radiation physics research at Bell Laboratories since 1967; he is Visiting Associate Professor of Physics this year, working on research in the Laboratory for Nuclear Science.

— **Takaaki Nagao,** Associate Professor of Mechanical Engineering at the University of Tokyo, is holding a similar position as a visiting member of the M.I.T. faculty. His work is in the field of materials — casting, welding, plastic working, and heat treatment.

— **Judit Nemeth,** Professor of Physics at Eotvos University, Budapest, Hungary, has been Visiting Abby Rockefeller Mauzé Professor in the Department of Physics, working on nuclear theory in the Center for Theoretical Physics. It is Dr. Nemeth's first visit to the U.S.

— **G. Theodoor J. Overbeek** of the University of Utrecht, the Netherlands, is Carbon P. Dubbs Visiting Professor of Chemical Engineering, teaching in the field of surface chemistry and working with the Center for Advanced Engineering Study on filmed courses in chemical theory.

— **Moselio Schaechter,** Chairman of the Department of Biology and Microbiology at Tufts University, is Visiting Professor of Chemistry at M.I.T. this year; he has been a post-doctoral fellow of the American Cancer Society and a career development awardee of the National Institutes of Health.

— **Allen Sinai,** a specialist in macroeconomic and monetary theory who is Associate Professor of Economics at the University of Illinois at Chicago, is Visiting Associate Professor in the Sloan School of Management for the current academic year.

— **Norman S. Stearns,** M.D., an internist and cardiologist whose current interest is in continuing medical education, is Visiting Professor in the Sloan School of Management to work in developing "dynamic consultation" — an approach used to overcome organizational and behavioral barriers to change in hospital management. Dr. Stearns is Associate Dean for Continuing Medical Education at Tufts University School of Medicine, Boston.

— **James T. Woo,** Sc.D. '66, is back at M.I.T. as Visiting Associate Professor of Nuclear Engineering; he is on leave from United Aircraft Research Laboratories, where his work has been on the use of lasers in high-technology energy systems. □

Faculty Appointments

Twenty-six appointments to the M.I.T. faculty have been announced in Cambridge during the current academic year. They are:

— **Gregory B. Baecher,** Ph.D. '72, Assistant Professor of Civil Engineering. Since completing graduate work at M.I.T., Dr. Baecher has studied the siting of large civil facilities at the International Institute for Applied Systems in Austria on a Rockefeller post-doctoral fellowship, and he now returns to M.I.T. to continue research and teaching in this field.

— **Janos M. Beer,** Professor of Chemical Engineering. Professor Beer is a native of Hungary, a graduate of the University of Budapest in economics and chemical engineering, and formerly Head of the Combustion Division of the Hungarian Heat Research Institute. He has been Head of the Chemical Engineering Department at the University of Sheffield (England), where he studied for doctorates in 1966 and 1968, and he has held energy research assignments in England, the Netherlands, and the U.S.

— **Robert J. Birgeneau,** Professor of Physics. Since 1968 associated with Bell

Laboratories in neutron scattering research, Professor Birgeneau will now devote full time to teaching and research at M.I.T. in solid-state spectroscopy. Professor Birgeneau studied at the University of Toronto (B.Sc. '63) and Yale (Ph.D. '66), and he has been a guest scientist at Brookhaven National Laboratory in the field of neutron scattering; his work at M.I.T. will be in the Center for Theoretical Physics.

— **Fisher Black,** Professor of Finance in the Sloan School of Management. Formerly at the University of Chicago, Professor Black studied physics and applied mathematics at Harvard and worked with Arthur D. Little, Inc., and Associates in Finance before opting for an academic career at the University of Chicago, where he has been associated with the Center for Research in Security Prices.

— **Judith Bostock,** Assistant Professor of Physics. A graduate of Trinity College, Dickinson College, and Georgetown University (Ph.D. '71), Dr. Bostock has taught physics at M.I.T. while working in crystal physics at the Naval Research Laboratory in Washington, D.C., since 1972.

— **Jean W. Bresnan,** Ph.D. '72, Associate Professor of Linguistics. Dr. Bresnan is on leave in 1975-76 to study under a Guggenheim Fellowship; since completing graduate work at M.I.T., she has taught at Stanford and the University of Massachusetts; she is Associate Editor of *Linguistic Inquiry,* and she has participated in research on the history and structure of English sponsored by the National Science Foundation.

— **Elzbieta Chodakowska-Ettinger,** Assistant Professor of Humanities. A native of Poland, Dr. Chodakowska-Ettinger completed graduate studies in English philosophy (M.A. '49) and American literature (Ph.D. '63) at Warsaw University before coming to the U.S. to be a Fellow at the Radcliffe Institute in 1967. She has been Visiting Assistant Professor of Humanities at M.I.T. since 1973.

— **Robert E. Cohen,** Edgerton Assistant Professor of Chemical Engineering. At M.I.T. since 1973, Dr. Cohen studied at Cornell University and California Institute of Technology (Ph.D. 1972). His research concerns the physics and chemistry of polymers, and the two-year Edgerton Professorship appointment is designed to provide special career development and research opportunities.

— **Flora Y. F. Chu,** Assistant Professor of Electrical Engineering. Dr. Chu was formerly lecturer at the University of Wisconsin, from which she earned three undergraduate and graduate degrees in electrical engineering between 1971 and 1974.

— **Rudiger Dornbusch,** Associate Professor of Economics. Dr. Dornbusch studied at the University of Chicago (Ph.D. '71), and has taught at the University of Rochester and (as Associate Professor of International Economics) at the University of Chicago; he came to M.I.T. last fall after one year as a research fellow at the London School of Economics.

— **Alan J. Grodzinsky,** Ph.D. '74, Edgerton Assistant Professor of Electrical Engineering and Computer Science. Dr. Grodzinsky has been a member of the faculty since completing his doctorate, specializing in the electrical properties of such biological materials as collagen and membranes.

— **Stanley R. Hart,** '56, Professor of Geology and Geochemistry. A member of the Carnegie Institution of Washington since receiving his Ph.D. from M.I.T. in 1960, Dr. Hart was Visiting Associate Professor at the University of California (San Diego) in 1966-67. His research centers on geochronology, utilizing isotope geochemistry to understand the history and evolution of the earth's crust and mantle.

— **J. Karl Hedrick,** Associate Professor of Mechanical Engineering. A specialist in transportation systems and vehicles, Dr. Hedrick holds degrees from the University of Michigan and Stanford (Ph.D. '71). He was a member of the faculty at Arizona State University before coming to M.I.T. as Visiting Associate Professor in 1974.

— **Peter A. Holland,** Associate Professor of Physical Education. Professor Holland has completed his fifth year as head rowing coach at M.I.T.; he is a graduate of Dartmouth and Wesleyan, and he was assistant coach at Dartmouth before coming to the Institute.

— **David G. Holmes,** Ph.D. '73, Edgerton Assistant Professor of Mechanical Engineering. Professor Holmes began studies of noise control and sound propagation while a graduate student at the Institute; his earlier academic work was at Cambridge and Harvard Universities, and he joined the M.I.T. faculty in 1973.

— **David E. Housman,** Assistant Professor of Biology. Dr. Housman was at M.I.T. as a postdoctoral fellow from 1971 to 1973, before taking a teaching post in medical biophysics at the University of Toronto. His degrees are from Brandeis University (Ph.D. '71), and he has been a member of the Division of Biological Research at the Ontario Cancer Institute.

— **Hubert E. Jones,** Associate Professor of Urban Studies and Planning. Professor Jones holds a master's degree in social work from Boston University and since 1971 has been associated with the M.I.T. Community Fellows Program.

— **Donald R. Lessard,** Ford Assistant Professor of Management. As a member of the faculty of the Sloan School of Management, Professor Lessard has been coordinator of a large M.I.T. study of mortgage financing and has written research papers on international diversification and international finance. At M.I.T. since 1973, Professor Lessard's new Ford Professorship is one of a series intended for untenured faculty with research interests in international policies, economics, management, or urban planning. Dr. Lessard is a graduate of Stanford (Ph.D. '70).

— **Raymond E. Levitt,** Assistant Professor of Civil Engineering. Dr. Levitt completed graduate study at Stanford in June; he has had experience in building design and construction in South Africa, Canada, and California.

— **John E. Meyer,** Professor of Nuclear Engineering. A graduate of Carnegie Institute of Technology, Professor Meyer has been with the Westinghouse Bettis Atomic Power Laboratory since receiving his doctorate in mechanical engineering in 1955; his work has been in submarine nuclear reactor design and reactor fuel element analysis, and at M.I.T. he has assumed leadership of work in nuclear reactor structural analysis.

— **Edward Y. Miller,** Assistant Professor of Mathematics. A graduate of the University of Pennsylvania (B.A. '64) and Harvard (Ph.D. '73), Professor Miller was C.L.E. Moore Instructor in Mathematics at M.I.T. for two years before joining the faculty on July 1.

— **Julian Szekely,** Professor of Materials Science and Engineering. A native of Hungary, Dr. Szekely was educated at Imperial College, London (Ph.D. '61) and worked in British industry before coming to the U.S. in 1966; he has recently been Professor of Chemical Engineering and Director of the Center for Process Engineering at the State University of New York, Buffalo; he holds the McGraw Research Award of the American Society for Engineering Education and the Professional Progress Award of the American Institute of Chemical Engineers, and he is the author of books and papers in the field of process metallurgy.

— **Toyoichi Tanaka,** Assistant Professor of Physics. Dr. Tanaka, who came to M.I.T. in 1972, holds degrees from the University of Tokyo (Sc.D. '72); he has since then held research appointments in the Department of Physics and at the Retina Foundation of Boston.

— **Michael J. Underhill,** '70, Assistant Professor of Architecture. Professor Underhill studied at Harvard for his master's degree (1974), and he has taught at M.I.T. as assistant and instructor in 1968-70 and 1972-73.

— **Lothar Wolf,** Associate Professor of Nuclear Engineering. Professor Wolf, educated at the Technical University of Berlin, came to M.I.T. last year under an exchange program with that institution; now he will stay to teach in heat transfer and fluid dynamics as related to nuclear reactor engineering. He taught at T.U.B. from 1967 to 1974.

— **Kyu S. Woo,** Associate Professor of Architecture. As Senior Designer for the Mayor's Office of Midtown Planning and Development in New York City, Professor Woo has most recently been Project Director for the Broadway Plaza proposal for Times Square. Earlier he had been with Sert, Jackson and Associates and — before coming to the U.S. — Chief Urban Designer at the Housing, Urban, Regional, and Planning Institute in Seoul, Korea. Professor Woo's degrees are from Harvard (M.Arch. '70), Columbia, and the Seoul National University. □

Individuals Noteworthy

Kudos: Honors, Awards, Citations

To **Irwin I. Shapiro**, Professor of Geophysics and Physics at M.I.T., the Albert A. Michelson Medal of The Franklin Institute for his role in the development and application of radar astronomy . . . to **Ignacio Rodriquez-Iturbe**, Visiting Associate Professor of Civil Engineering at M.I.T., the Walter L. Huber Civil Engineering Prize of the American Society of Civil Engineers for his research in hydrology . . . to **Richard Stanley**, '63, Associate Professor of Applied Mathematics at M.I.T., the Polya Prize of the Society of Industrial and Applied Mathematicians . . . to **C. C. Lin**, Institute Professor of the Department of Mathematics at M.I.T., the Timoshenko Medal for 1975 of the American Institute of Mechanical Engineers for his contribution to fluid mechanics.

To **Dirk J. Struik**, Professor Emeritus in the Department of Mathematics at M.I.T., a gold medal of achievement from the National University of Mexico for his service to the teaching and development of mathematics in that country . . . to **Marguerite Heywood**, Assistant for Health Information and Education in the M.I.T. Medical Department, the Minnie E. Kelley Award of the Simmons College School of Social Work for her outstanding paper on child welfare . . . to **August F. Witt**, Professor of Materials Science and Engineering at M.I.T., the Wilhelm Exner Medal of the Austrian Free Trade Association . . . Joint recipients of the 1975 Raymond C. Reese Research Prize of the American Society of Civil Engineers (for their paper "Human Response to Wind-Induced Motion of Buildings"): **Robert J. Hansen, Erik H. Vanmarcke**, Ph.D. '70, professors in the Department of Civil Engineering at M.I.T.; and **John W. Reed**, Ph.D. '72.

To **Richard L. de Neufville**, '60, Associate Professor of Civil Engineering at M.I.T., the 1975 award from the Special Programme Panel on Systems Science of the North Atlantic Treaty Organization . . . to **Daniel E. Murnick**, Ph.D. '66, Visiting Professor of Physics at M.I.T., a 1975 George M. Estabrook Distinguished Service Award of the Hofstra University Alumni Association . . . to **Robert Mayer White**, Sc.D. '50, Administrator of the National Oceanic and Atmospheric Administration, the David B. Stone Medal of the New England Aquarium . . . **I. M. Pei**, '40, member of the M.I.T. Corporation, to the American Academy of Arts and Letters; and to the architectural firm of I. M. Pei and Partners, the 1975 Harleston Parker Medal of the Boston Society of Architects for the 16-acre Christian Science Church building and park development . . . to **John B. Delos**, Ph.D. '70, Assistant Professor of Physics at the College of William and Mary, the 1975 Faculty Award for the Advancement of Scholarship of Virginia's Alpha chapter of Phi Beta Kappa.

Frederic Lawrence Holmes, '54, was chosen by the History of Science Society for the 1975 Pfizer Award for his book *Claude Bernard and Animal Chemistry, The Emergence of a Scientist*; the award was presented by **Gerald D. Laubach**, Ph.D. '50, President of Pfizer, Inc. . . . to **Daniel U. Wilde**, Ph.D. '66, Director of the New England Research Application Center, a public service award from the National Aeronautics and Space Administration . . . to **Mark A. Dobbels**, S.M. '71, the U.S. Air Force Commendation Medal . . . to **Arthur Olney Williams, Jr.**, '36, the Hazard Professorship at Brown University . . . Two alumni honored by the American Institute of Chemical Engineers for 1975: **Alan S. Michaels**, '44, to be their 27th Annual Institute Lecturer; and **C. Judson King**, Sc.D. '60, the Food, Pharmaceutical, and Bioengineering Award. . . . to **Peter Griffith**, Sc.D. '56, Professor of Mechanical Engineering at M.I.T., the Heat Transfer Memorial Award of the American Society of Mechanical Engineers.

Counselors: Officers, Directors, Advisors

Herman Feshbach, Ph.D. '42, Professor of Physics and head of that department at M.I.T., to University Trustee of the Associated Universities, Inc., Washington, D.C. . . . **Wesley L. Harris, Sr.**, Associate Professor of Aeronautics and Astronautics and Associate Professor of Ocean Engineering at M.I.T., to the Aero Acoustics Technical Committee of the American Institute of Aeronautics and Astronautics . . . **Jacquelyn Anderson Mattfeld**, former Associate Dean of Student Affairs at M.I.T., to President of Barnard College in New York City.

Appointed to two advisory groups by President Ford: **Edward E. David, Jr.**, Sc.D. '50, Executive Vice President of Gould, Inc., **J. Herbert Hollomon**, '40, Professor of Engineering and Director of the Center for Policy Alternatives at M.I.T., and **Norman Rasmussen**, Ph.D. '66, Professor and Head of the Department of Nuclear Engineering at M.I.T., to the Advisory Panel on Contributions of Technology to Economic Strength; and **Manson Benedict**, Ph.D. '35, Institute Professor Emeritus and professor in the Department of Nuclear Engineering at M.I.T., **Solomon J. Buchsbaum**, Ph.D. '57, Executive Director of Research at Bell Laboratories, **Frank Press**, Professor and Head of the Department of Earth and Planetary Sciences, **Murray Gell-Mann**, Ph.D. '51, professor at California Institute of Technology, and **Arthur Kantrowitz**, Visiting Institute Professor of Mechanical Engineering at M.I.T., to the Advisory Panel on Anticipated Advances in Science and Technology.

E. Kirkbride Miller, '41, to Chairman of the Board of T. Rowe and Price Associates, Inc. . . . **D. Quinn Mills**, Professor of Management at M.I.T., to Chairman of the new Construction Industry Collective Bargaining Committee of the U.S. Department of Labor . . . **Hamilton Herman**, '43, to Assistant Secretary of Transportation for Systems Development and Technology of the U.S. Department of Transportation . . . **Joseph K. Dillard**, S.M. '50, Manager of Advanced Systems Technology for Westinghouse, to President of the Institute of Electrical and Electronic Engineers . . . **Henry A. Hill**, Ph.D. '42, President of Riverside Research Laboratory, to President of the American Chemical Society . . . **Arthur E. Humphrey**, S.M. '60, Dean of Engineering at the University of Pennsylvania, to a director of the American Institute of Chemical Engineers . . . **Kenneth L. Block**, '47, Chairman of the Board of A.T. Kearney, Inc., to a member of The Conference Board, an independent and nonprofit business and economic research organization.

Rising in the World of Business

Herman R. Staudt, S.M. '68, President of Borg Textile Corp., a new subsidiary of the Bunker Ramd Corp. . . . **Thomas R. Williams,** S.M. '54, Chief Executive Officer of The First National Bank of Atlanta and First National Holding Corp. . . . **Anthony Chemel,** '38, Senior Vice President of Armbrust Chain Co. . . . **George W. Bierman,** Ph.D. '56, President and Chief Operating Officer of Herbert V. Shuster, Inc. . . . **Jess L. Belser,** '52, Executive Vice President of Continental Can Co. and President of Continental's Forest Products Group . . . **Rex M. Ball,** '58, President of H.T.B., Inc. (Hudgins, Thompson, Ball and Associates) . . . **George E. Lamphere,** '54, Vice President of Chas. H. Tompkins Co., a subsidiary of J. A. Jones Construction Co.

Leonard Zacks, '66, Vice President of Becker Securities Corp., Chicago . . . **James M. Osborne,** S.M. '61, Corporate Vice President of New Business Development and Planning for E-Systems, Inc. . . . **Scotty B. Patrick,** '57, Vice President and General Manager of the Resins and Plastics Division of Ashland Chemical Co. . . . **John Lovkay, Jr.,** '58, Vice President for Electronic Systems of Hamilton Standard, a division of United Technologies . . . **Robert W. Wilson,** S.M. '71, Vice President of the Tactical Systems business line for Avco Systems Division.

Items of Interest

Gyorgy Kepes, Director Emeritus of the M.I.T. Center for Advanced Visual Studies and Institute Professor Emeritus, was the second Compton Lecturer for 1975-76 . . . **Phyllis A. Wallace,** Professor of Management at the Sloan School and author of *Equal Employment Opportunity and the A.T.&T. Case*, was the guest of the Boston television program "Women '75" . . . **Andrew Silver,** '64, directed "Next Door," a short story by Kurt Vonnegut, Jr., adapted for television . . . Lecturers at the 96th Annual Meeting of the American Society of Mechanical Engineers: **Robert C. Seamans, Jr.,** S.M. '42, on "Latest Developments in Energy Research and Development" for the Henry Robinson Towne Lecture; **Myron Tribus,** Professor of Engineering and Director of the Center for Advanced Engineering Study at M.I.T., on "Along the Corridors of Power, Where are the Engineers?" for the Thurston Lecture; and **Hunter Rouse,** '29, Carver Professor Emeritus at the University of Iowa, on "Origins of the Francis and Pelton Turbines."

M.I.T. Appointments

Two members of the faculty have new roles in the administration of the M.I.T. Mathematics Department — **Daniel J. Kleitman,** Professor of Applied Mathematics, as Chairman of the Applied Mathematics Committee; and **Gilbert Strang,** '55, Professor of Mathematics, as Chairman of the Pure Mathematics Committee . . . **Alice Seelinger,** who has been a member of the staff of the Dean for Student Affairs office for 11 years, is Assistant Dean for Student Affairs with primary responsibility for graduate student housing; she'll continue as Administrative Officer of the office. . . . **Lewis A. Redding,** formerly with the Boston Redevelopment Authority after serving with the Peace Corps in Guatemala, is Personnel Officer in the Office of Personnel Services. □

John E. Burchard, 1898-1975: Uniting the Worlds of Science and Humanities

John Ely Burchard, '23, Dean Emeritus of the School of Humanities and Social Science, who was for more than 20 years a brilliant advocate for the humanistic and social studies in an institution focussing on science and technology, died December 25 at Massachusetts General Hospital. He was 77.

". . . an intellectual leader and a rare human being," said President Jerome B. Wiesner of Dr. Burchard in a memorial tribute. "His creative genius in the arts and letters was enriched with a deep understanding of their relationship to the natural sciences. Drawing upon his education and background in architecture, he developed a vision of what the humanities and the arts could do on this campus, and that vision was an important force in establishing within the Institute the traditions of a modern university," said Dr. Wiesner.

M.I.T.'s other leaders joined in tribute. "Historian, critic, humanist, he epitomized the ideal of the Renaissance man," said Howard W. Johnson, Chairman of the Corporation. "He helped in countless ways to shape the present style and character of the Institute."

James R. Killian, Jr., '26, called him "a great teacher and a distinguished scholar . . . (whose) place in the history of the Institute is assured and (whose) passing will be mourned by thousands of M.I.T. alumni."

John E. Burchard, '23
(painting by Dorothy Rand Greenough)

Dr. Burchard first came to M.I.T. in 1919, following World War I service with the Army Medical Corps; a native of Marshall, Minn., he had earlier studied more than two years at the University of Minnesota. After receiving his S.B. in architectural engineering, Dr. Burchard continued for his S.M. (1925) in the same field while acting as Assistant to the Head of the Department of Civil and Sanitary Engineering; at the same time he was teaching English (1924-25) and ar-

Continued on page 94

chitecture (1926-30) on a part-time basis, thus beginning the union of the visual, technological, and humanistic disciplines which he was later to seek for M.I.T. as a whole.

For 13 years beginning in 1925 Dr. Burchard was associated with Bemis Industries, Inc., Boston, rising to become its Director of Research, Vice President, and Director. He returned to M.I.T. in 1938 to become Director of the Albert Farwell Bemis Foundation and Professor of Architecture, and six years later he was named Director of Libraries. Meanwhile, from 1940 to 1946 he was on leave for World War II work with the National Defense Research Committee, where he led study committees and military missions concerned with many aspects of the war effort.

Back in Cambridge following the war, Dr. Burchard was responsible for working with the architects on design of the Charles Hayden Memorial Library and through this project became involved nationwide in library planning and design activities. Then, in 1948, came his appointment as Dean of Humanities and, in 1950, as the first Dean of the School of Humanities and Social Science — the role in which were made his major contributions to the development of the Institute. By the time of Dr. Burchard's retirement in 1964 that School's leadership was unquestioned, fulfilling the vision — previously untested — of humanities and social sciences strengthening scientific and technological education and at the same time drawing strength for themselves from an environment of science and engineering education.

Dr. Burchard was the Institute's official host to Sir Winston Churchill at the Mid-Century Convocation in 1948 and again for British Prime Minister Harold Macmillan at the Centennial Convocation in 1961; he was General Chairman of both landmark convocations.

Following retirement in 1964, Dr. Burchard taught at the University of California (Berkeley), where he was for two years Acting Dean of the College of Environmental Design, and worked as principal consultant to the Bay Area Rapid Transit Authority. He then returned to Boston and only recently, despite four years of declining health, completed a book of architectural criticism, *Architecture and the Social Purpose*, to be published this spring. A prolific writer on social and architectural issues, Dr. Burchard was earlier the author or co-author of such works as *The Architecture of America — A Social and Cultural History* (with Albert Bush-Brown), *The Historian and the City* (with Oscar Handlin), *The Evolving House* (with Albert Farwell Bemis), and *The Voice of the Phoenix: Post-War Architecture in Germany*.

Dr. Burchard was President of the American Academy of Arts and Sciences from 1954 to 1956, and he considered his initiatives leading to the present form of the Academy's journal *Daedalus* to be among his proudest achievements. □

Joseph W. Barker, 1891-1975

J. W. Barker

Joseph W. Barker, '16, noted as an engineering educator and as advocate of academic research, died in New Rochelle, N.Y., on December 10 following an extended illness. He was 84.

Dr. Barker was a member of the M.I.T. faculty from 1925 to 1929, when he left to become Head of the Department of Electrical Engineering at Lehigh University (1929-30) and Dean of Engineering at Columbia University (1930-46).

It was while Dr. Barker was leading the Engineering School at Columbia that he first became a Director of Research Corporation, a foundation devoted to the advancement of science and the management of innovations arising out of academic research. As Director from 1934 to 1959 and as Chairman of the Board for 12 years, Dr. Barker was a principal figure in the activities of that corporation.

Dr. Barker entered M.I.T. from Lawrence, Mass., and he served in the U.S. Army during World War I and until rejoining the Institute. He was Assistant to the Secretary of the Navy during World War II, responsible for Navy educational and training programs; at the end of the war he received the Navy Distinguished Service Award.

Dr. Barker's death ends a career of significant service to M.I.T. through the Alumni Association and the Class of 1916, of which he was Vice President and Class Agent. Dr. Barker received the Association's Bronze Beaver Award in 1966. □

Henry L. Seaver, 1878-1975

Henry L. Seaver, Professor of History, Emeritus, in the Department of Architecture who had been a member of the staff at M.I.T. for 46 years when he retired in 1947, died in Lexington, Mass., on November 26. He was 97.

Professor Seaver came to M.I.T. in 1901 to teach in the Department of English and History, following one year of teaching at Harvard. His bachelor's degree was from Harvard (1900), and he continued part-time

studies for a master's degree in English (1914).

Having been made Professor of English and History in 1929, Professor Seaver in 1933 joined the Department of Architecture to teach art and architectural history; a private autograph collection was one of his popular "teaching aids." Professor Seaver shared with his cousin, William Seaver (he was M.I.T.'s third Librarian, from 1924 to 1947), an interest in fine books and printing; he was also skilled in lithography, weaving, woodcutting, and bookbinding. After retirement from M.I.T., Professor Seaver became an active member and benefactor of the Massachusetts Historical Society, and he was known as a popular Sunday afternoon lecturer at the Museum of Fine Arts. □

Mac V. Edds, Jr., 1917-1975

Mac V. Edds, Jr., who became Executive Director of the Neurosciences Research Program and Professor of Neurobiology in the Department of Nutrition and Food Science in January, 1975, died suddenly on November 29. He was 58.

Prior to joining M.I.T., Dr. Edds had been Dean of the Faculty of Natural Sciences and Mathematics at the University of Massachusetts, Amherst, and earlier he had been Chairman of the Department of Biology at Brown University. He was trained as an embryologist (A.B. Amherst, 1938, Ph.D. Yale, 1943) but was nationally respected for research contributions in all of the life sciences. □

Lawrence B. Arguimbeau, 1906-1975

Lawrence B. Arguimbeau, who taught in the field of electrical communications at M.I.T. from 1939 until 1954 and lived in Onset, Mass., following retirement from active consulting in 1971, died on November 22. He was 69.

Professor Arguimbeau came to the Institute from General Radio Co. following graduation from Harvard in 1930. Harold L. Hazen, '24, Dean Emeritus of the Graduate School who was Head of the Department of Electrical Engineering during much of Professor Arguimbeau's tenure, recalls him as "an extraordinary, very much cherished teacher."

It was in 1953 that Professor Arguimbeau came under pressure from the House Un-American Activities Committee because of earlier activities as a member of the Communist Party. He responded by answering all questions concerning himself while refusing to answer those concerning others, and by resigning his faculty post in 1954 to save the Institute further embarrassment. For more than 15 years thereafter he worked on communications components and, more recently, on medical electronics for private industry. □

Deceased

Adolph E. Place, '03; November 6, 1972; 531 Avenue L, Boulder City, Nev.
Leavitt N. Bent, '06; October 2, 1975; Oxford, Md.
John C. Kinnear, Sr., '07; September 28, 1975; 1116 Riverside Dr., Los Altos, Calif.
William F. Dolke, '08; November, 1975; El Rancho Village, 15 Ranchero Cir., Bradenton, Fla.*
William H. Medlicott, '08; August 28, 1975; 2005 S. Vine St., Urbana, Ill.
George Harrison Gray, '09; July 25, 1975; 76 Pleasant St., Natick, Mass.
Thomas C. Montgomery, '09; October 13, 1975; 1405 40th Ave., Rock Island, Ill.
Harold Lockett, '10; November 4, 1975; 1441 Jackson Ave., New Orleans, La.
George A. Cowee, '11; August 13, 1975; 493 Chateau Dr. N.W., Atlanta, Ga.
Elisha N. Fales, '11; December 22, 1970; Edsall Rd., Alexandria, Va.
Edwin Pugsley, '11; November 19, 1975; 76 Everit St., New Haven, Conn.
Parker J. Brown, '12; November 18, 1975; 44 Pleasant St., Revere, Mass.
Hou Kun Chow, '14; June 28, 1975; 3 Humbert St., Flat C, Lai Chi Kok, Kowloon, Hong Kong*
Ralph D. Salisbury, '14; October 13, 1975; 19 Sunset Beach Mesa, Watsonville, Calif.
Carl K. Springfield, '14; November, 1975; 1412 N. Fourth St., Sayre, Okla.*
Harvey W. Daniels, '15; May 21, 1975; 1025 Langer Way, Delray Beach, Fla.*
Joseph W. Barker, '16, December 10, 1975; 45 Beechmont Dr., New Rochelle, N.Y.*
Paul D. Harrower, '16; November 1, 1975; 215 Ft. Pleasant Ave., Apt. G-9, Springfield, Mass.*
Robert M. Kallejian, '16; June 10, 1975; 10004 Cole Rd., Whittier, Calif.*
Earl R. Mellen, '16; November 3, 1975; 393 Wyoming Ave., Millburn, N.J.
Merrick A. Monroe, '16; April 3, 1975; 190 Nearwater Ln., Noroton, Conn.
Arthur S. Neave, '16; April 5, 1975; 440 Lafayette Ave., Apt. 8, Cincinnati, Ohio
Richard Rowlett, '16; June 18, 1975; 1227 S. Highland Ave., Clearwater, Fla.
Garland Fulton, '17; October 24, 1975; 307 Clwyd Rd., Bala Cynwyd, Penn.*
Carl E. Geiger, Jr., '17; October 17, 1975; Buck Creek Rd., R.F.D. #2, Floyd's Knobs, Ind.
Frank H. Randolph, '17; October 22, 1975; 101 Oxford Pl., Ithaca, N.Y.*

Samuel J. Zeigler, '17; October 24, 1975; 1 Pooks Hill Rd., #316, Bethesda, Md.
John W. Damon, '18; May 23, 1975; Boot Pond Rd., R.F.D. #4, Plymouth, Mass.
Francis W. Sears, '20; November 13, 1975; S. Hill Rd., Box 131, Grahamville, N.Y.
Haskins B. Canfield, '22; October 29, 1975; 6527 Bramble Cove, Memphis, Tenn.
Arthur L. Flanders, '22; September, 1975; 6118 Hurst St., Houston, Tex.
William E. Huger, '22; November 15, 1975; 95 Valley Rd. N.W., Atlanta, Ga.*
Alexander G. Nichols, '22; August 5, 1975; 3310 Monte Vista St., Point St. Lucie, Fla.
Thomas M. Taylor, '22; December 5, 1975; 3410 Gulf Shore Blvd. N., Naples, Fla.
Benjamin W. Thoron, '22; April 30, 1975; 3019 P St. N.W., Washington, D.C.*
John E. Burchard, '23; December, 1975; 56 Mt. Vernon St., Boston, Mass.
Daniel B. Coleman, '23; June 22, 1975; 23 S. Elizabeth Ave., Ferguson, Mo.*
Douglas K. Severn, '23; November 19, 1975; 34 Sholes Ave., Norwich, Conn.*
Malcolm S. Blake, '25; November 5, 1975; 233 River St., Norwell, Mass.
Finlay G. Cameron, '25; November 4, 1975; 1730 Ave. Del Mundo #309, Coronado, Calif.
Edwin L. Harris, '25; July, 1975; 32 Southwood Ave., Ross, Calif.*
James S. Radcliffe, '25; April 27, 1975; 102 Spring Lake Gardens, Spring Lake, N.J.
Philip A. Welch, '25; September, 1975; 18 Shippen Ave., Warwick, R.I.*
O. Howard Biggs, '26; November 30, 1975; 56 Colon St., Beverly, Mass.
George Wardner, '26; December 23, 1975; Box 306, 261 Grove St., Wellesley, Mass.
Charles A. Bartlett, '27; December 21, 1975; 22 W. Elm St., Yarmouth, Me.
James F. Collins, '27; July 31, 1975; 16 Coolidge Rd., Belmont, Mass.
Sara A. Scudder, '27; December, 1975; 130 East 57th St., New York, N.Y.
John C. McCune II, '28; November 1, 1975; Box 1, Selinsgrove, Penn.*
John B. Russell, '28; August 11, 1975; S. Hill Rd., Box 131, Grahamville, N.Y.*
Robert N. Tucker, '28; June 29, 1975; 4128 Sr.-412, Vickery, Ohio*
Alvah E. Perkins, '30; August 26, 1975; 496 Defense Hwy., Gambrills, Md.
Francis A. Carboine, '32; May 13, 1975; 9 Linden St., Garden City, N.Y.
Maurice L. Brashears, '33; December 7, 1975; 4129 Northmeadow Cir., Carrollwood Village, Tampa, Fla.
Emerson P. Hempstead, '34; December 3, 1975; 59 Zaccheus Mead Ln., Greenwich, Conn.*
Samuel Litman, '37; February, 1975; 120 Saluda Ave., Columbia, S.C.
Anthony J. Chenis, '38; May 2, 1975; Box W., Fairfield Hills Hospital, Newton, Conn.
William H. Kashdan, '38; September 14, 1975; 1274 Pulaski Rd., E. Northport, N.Y.
Hendrik Bruynes, '39; October, 1975; 160 Castle Hill, R.G.I. 7RP, Reading, Berkshire, England*
Joseph R. Burns, '40; October, 1975; 65 Farragut Rd., Swampscott, Mass.
A. Gordon Hull, '40; November 28, 1975; Bayview Dr., Jamestown, R.I.
Elliott D. Friedman, '42; November 27, 1975; 16 Jody Ln., Plainview, N.Y.
Julian Gammon, Jr., '45; November 6, 1975; 5230 Westminster Pl., Pittsburgh, Penn.
Lawrence W. Keepnews, '45; April 21, 1975; 542 Pelhamdale Ave., Pelham, N.Y.
John W. Delaplaine, '46; January 28, 1975; 6402 W. Halbert Rd., Bethesda, Md.
May M. Fitz Hugh, '47; January 22, 1975; 1617 No. Albemarle St., McLean, Va.
Edward M. Berly, '49; September 9, 1975; 149 Christina St., Newton Highlands, Mass.
Katherine Hansen, '53; December 3, 1975; 15 Paul Revere Rd., Bedford, Mass.
John F. O'Dowd, '56; September 12, 1975; 9 Victoria Ln., Hot Springs Village, Ariz.
Winson J. Ewing, '60; November 2, 1975; 170 Westover Dr., Delran, N.J.
Eric L. Schindler, '68; November 29, 1975; 3416 Tulane Dr., Adelphi, Md.
Judson I. Rich, '72; April 7, 1974; 2923 W. Jarvis Ave., Chicago, Ill.
Larry S. Pensak, '73; December 10, 1975; 103 Hammond St., Cambridge, Mass.

* Further information in *Class Review*

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A recent visit to the Fuller Memorial-Brockton Art Center showed that this unique institution continues to grow in its service to Brockton and the surrounding communities. Established by the will of **Myron Fuller,** the center is used by school children of the Brockton schools and many other schools situated in the vicinity. One local college has developed a course which uses many of the center's facilities. This year there is an exhibit of ancient Greek and Roman objects on loan from the Boston Museum. — **Clare Driscoll,** Acting Secretary, Good Hope School, Frederiksted, St. Croix, V.I. 00840

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I have no news to report to the Class this month which must mean that all news is good.

Peggy and I hope your Christmas was a merry and blessed one and that your New Year will be happy.

Good luck and best wishes to our Alma Mater in these trying times. — **William G. Ball,** Acting Secretary, 6311 Fordham Pl., Bradenton, Fla. 33507

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We regret to report the death of another classmate: **William F. Dolke,** 88, of 15 Ranchero, Bradenton, Fla., died November 21, 1975 at Manatee Memorial Hospital. He had his own architectural and engineering business in Chicago, Ill., where he was well known for over 50 years. He was a long-time member of Rotary. He leaves his wife, Carol Dolke, two daughters, Mrs. James Taggart, and Miss Dorothy Dolke of Woodstock, Ill., and one son William F. Dolke of Rochester, N.Y., ten grandchildren and four great-grandchildren. — **Joseph W. Wattles III,** Secretary, 26 Bullard Rd., Weston, Mass. 02193

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Harold Mayer wrote in November of his trip by train from Vancouver to Winnipeg, through mountains streaked with snow and a blue sky above. In Winnipeg he was staying at the Empire Hotel, and he expected to spend Christmas with his son's family in Milwaukee. During the Canadian mail strike, Harold was able to send mail to the United States by putting U.S. stamps on it and having a bus-driver post it in Fargo, N.D. . . . A letter from **Jim Reber,** also in November, reported his return to Houston for the winter, after four months at his summer home in Auburn, N.Y. While he was north, he and Aminda visited Norwich University, of which our classmate, **Porter Adams,** was once president. With his letter Jim sent a picture of the tower which contains the carillon that Porter's wife gave to the university in his memory. The Rebers went also to Jim's 65th anniversary at Mercersburg Academy, where he was the only member of his class present and received a rising greeting from the others there. . . . Another November letter was from **Alden Waitt,** who was at Fort Gordon, Ga., for Thanksgiving with his daughter and son-in-law. Alden and Kathryn celebrated their 58th anniversary at a 150-year-old mansion in Thompson, Ga., "full of priceless antiques — appropriate for a couple of antiques ourselves."

The Alumni Records Office has received word of the death of **Hou Kun Chow** on June 28, 1975, in Hong Kong, where he had lived in recent years and was Director and Secretary of the New China Enamelware Co. (H.K.). He was with us in our third and fourth years, received his bachelor's degree in Course XIII and later a master's in Course XVI. After two years with Curtiss Aeroplane Co. in Buffalo, he returned to his home city of Shanghai, where he was with several companies until 1963. He is survived by his widow.

Lee Duff thoughtfully telephoned me to report the death of **Walter P. Keith** on November 28, 1975, at the age of 85, in a nursing home in Akron, the city in which he had lived ever since his graduation from the Institute. He was a member of our class, in Course X, from the time we entered. After working with several companies in Akron, he became President and Treasurer of the Hygienic Dental Rubber Co. in 1948 and later founded the Hygienic Dental Manufacturing Co., of which he was President until he retired in 1971 and was succeeded by his son, Walter, Jr. (M.I.T. '41). In 1973 Walter received the Akron Dental Society's Award of Merit for Professional Community Service. He was President of the Akron Art Institute for 12 years, after joining its board in the early 1940s at the beginning of a long rebuilding campaign. Walter was also a life member of the Salvation Army Board, for over 20 years was on the Board of the Akron General Medical Center, was a past President of the Rotary Club, a 32nd-Degree Mason, and a past Senior Warden of the Church of Our Savior. Lee Duff was among a large congregation at the funeral service in that church. In 1918 Walter married the former Fama I. Noyes, who survives him, as do his son and three grandchildren.

Carl K. Springfield died in Sayre, Okla., on October 31, 1975, at the age of 84. After receiving an A.B. degree from Boston University in 1911, he joined our class in our junior year and was awarded his S.B. degree with us in Course I. In World War I he was instructor at a master gunners' school as a second lieutenant in the Army. After engineering positions in companies in petroleum and allied industries in Texas and Louisiana, Carl went with United Carbon Co. in Sayre in 1939 and became its General Superintendent in 1948. He joined Taci Production Co. in 1954 and became a Vice President. Besides his widow, the former Edith Mitchell, he leaves two sisters, Miss May Springfield of Rochester, N.H., and Mrs. Alice Warren of West Newton. — **Charles H. Chatfield,** Secretary, 177 Steele Rd., West Hartford, Conn. 06119

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Happy New Year with the hope that you and your families have all enjoyed a pleasant holiday season.

The many attractive Christmas cards I received from and sent to widows of deceased classmates is a sad reminder of the many fine old friends who have passed on. Age takes its toll. Our sympathy to **George Easter** in Buffalo, for the sad loss of his wife. Margaret died suddenly on November 9, 1975.

More honors for our Classmates, **Clive Lacy** and **Phil Alger,** who have grandsons now at M.I.T. Roger W. Lacy, son of John W. Lacy, '42, is a freshman and Monty Alger, son of John R. M. Alger, '49, is a sophomore. Any one else who can boast a third generation at M.I.T.?

The "snow birds" from the North have made their annual flight to the alleged Florida sunshine — **Larry Landers, Max Woythaler** and **Jim Tobey.** Maybe some others have not yet reported. **Whit Brown** and **Bob Mitchell** live down there permanently.

Phil Alger has added another honor to his many in electrical engineering; on October 18 in Cincinnati he was elected to Tau Beta

Pi, the national honorary society in engineering and scientific knowledge. Congratulations Phil! We are considering a 61st Reunion, our usual cocktail party and dinner at the M.I.T. Faculty Club here in Cambridge, on the afternoon of Alumni Day in June. Plan to be there.

Harvey Daniels died in Del Ray Beach in May.

The old "Woof" **Alton Cook,** while visiting his family here for the holidays, spent an enjoyable afternoon with me. It was great to see him and I hope any other classmates who come to Boston will look me up. — **Azel W. Mack,** Secretary, 100 Memorial Dr., Cambridge, Mass. 02142

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We were pleased to receive a newsy Christmas letter from Mildred and **Art Shuey** in which they recounted their activities in the past year. They traveled to Mexico, Texas, Colorado, Missouri and Arkansas. After a very comfortable summer in Shreveport, "Then came the urge to go trout fishing and we spent the last of September and two weeks of October at Marble, Colo., in the Crystal River Valley. Never have we seen it so beautiful, the aspens turned fully golden, four planets were visible at night or early morning in the clear high mountain air, and the brook trout were greedy for my tiny Scottish flies. Coming home through Boulder we spent two pleasant days seeing the new Wallace F. Fiske Planetarium." Mildred and Art, we sincerely hope that your travels this year will include a trip to Chatham Bars Inn on June 1 to 3 when we will be celebrating our 60th Reunion. . . . Sylvia and **Vert Young** wrote, "See you at our 60th, we fondly hope." . . . Had this note from Gladys and **John Fairfield,** "A good year in our garden. You aren't healthy unless you sweat your shirt wet once a day and have dirt between your toes." . . . I learned from **Izzy Richmond**'s wife, Anne, that he is well and enjoying his retirement. You will recall that a couple of years ago, Izzy was hit by a car and had a bad break in his leg. The healing process was slow, but he is now in great shape. They will spend this winter in Fresno, Calif., and plan to attend our 60th in June. . . . Gladys and **Francis Stern** celebrated their 60th Wedding Anniversary on November 24. Wonderful!!! They made their annual pilgrimage to Palm Springs in early December where they will enjoy the balmy climate until April. . . . Had this welcome letter from **Lev Lawrason**: "I have never been able to attend any class reunions; in fact, I have not been in New England since graduation. I headed for Cuba in 1916 and since then have been in the Argentine. I seem to follow the oil producing areas. They are playing quite a role in our economy now. Still living at this retirement village of 10,000 old people. Have not met any M.I.T. men here. **Ken Sully** is living in the Laguna Leisure World, but as I don't drive on the freeway I don't see anyone."

Maury Holland pleased us with this note on his Christmas card: "Recently requested by my Alma Mater — 'National Research Council' — to serve as a coordinator on 'Policy and Plans' for Solar Energy in Rhode Island for homes and small businesses. My job is to mesh the interests of SCORE, Industrial Research Institute, and Rhode Island Development Commission." We'll enjoy your report of progress when we see you at our 60th, Maury. . . . Dorothy and **Dave Patten** wrote: "Since receiving your letter earlier this month I have been in contact with two of our classmates, **Don Webster,** and **Charlie Lawrance.** Don lives in Falmouth and since it is a pleasant drive from Duxbury to the Coonamessit Inn there, I often give Don a ring. He appears to be getting along well. Charlie Lawrance, Lois reports, is making recovery, from his last setback. Some medical appointments prevented us from going to the reunion in June. The system now is that we go to the medico instead of his coming to us. In other words it's a regular checkup rather than waiting until one needs treatment. We were in Washington for two celebrations, one a birthday party for 100 guests held at the Larz Anderson mansion with the host stipulating full-dress uniform, so it was a colorful affair. I managed very well with my old navy blues, in fact I weigh less now than in 1945. The other event was Dorothy's son, Major General Russell, being the recipient of the Air Force Association's highest award. Of course, no year would be complete without an annual visit to Maine."

We are sorry to report the passing of Classmates **Paul Harrower** on November 1, 1975; **Phil Baker** on December 10, 1975; and **Bob Kallejian** on June 10, 1975. Bob's daughter wrote: "I am sorry to tell you but my father, Robert M. Kallejian, died June 10, 1975 here in Whittier. He was born December 21, 1890 in Armenia, received a Pharmaceutical degree from Mass. College of Pharmacy in 1913, then a degree in pharmaceutical chemistry. Finally, a certificate of completion in Food and Drug Analysis at M.I.T. in 1916. He didn't have a Ph.D. His wife, my mother, was also born in Armenia, is still living at Cole Rd., in Whittier. My father worked over 50 years as a pharmacist and enjoyed his life. We were proud of him and his two alma maters. My son is now in a Ph.D. program at Harvard Medical School."

Finally, we report with regret the passing of our beloved classmate, **Joe Barker,** on December 10, 1975. The notice read in part: "Mr. Barker was a native of Lawrence and graduated from M.I.T. in 1916. He entered the U.S. Army in 1916 and served until 1925, when he became associate professor of engineering at M.I.T. Four years later he transferred to Lehigh University where he was professor and head of the department of electrical engineering. In 1930 he joined Columbia University as dean of engineering and remained there until 1946. During World War II he was assistant to the Secretary of the Navy, representing the Secretary on the War Manpower Commission and the joint Army-Navy board. He became a director of Research Corp., a science advancement foundation, in 1934 and was president from 1945 until 1957. He was chairman of the board from 1947 to 1959 and retired last January. Mr. Barker was active in alumni affairs at M.I.T., and vice president and class agent for his graduating class of 1916. In 1966 he received M.I.T.'s Bronze Beaver Award for service." None of us will ever forget Joe and his tremendous efforts on behalf of our Class and the Institute. We remember him vividly in his role as our 50th Reunion Gift Chairman when "as the plumed discoverer and toter of a real golden fleece in the bow of the Bucentaur he presented the record-breaking gift to M.I.T. Chairman Killian." One of our classmates appropriately expresses our sentiments with this note which he requested be printed in the Class Notes:

"To Mary Barker:

"The Class of 1916 will not forget Joe. He was the very body and soul of it. To try to put into words his contributions to us — to try to list his many, many deeds for us and the Institute — is beyond me to express.

"As a man, he set for each of us the highest ideals of fulfillment of life's meaning. His deeply religious devotion and his service to Trinity Church — his great technical knowledge which he passed on to others — his family life and devotion to you — all these contributed to the love and respect each of us felt for him.

"So, Mary, as long as there is a Class of 1916, Joe shall be of it and inspiring it.

Francis Stern"

Again, we look forward to your cards and letters. Keep writing. We hope that we will have the pleasure of seeing you at our 60th Reunion on June 1 to 3 in Chatham. — **Ralph A. Fletcher,** Secretary, W. Chelmsford, Mass. 01863

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Alumni Day in 1977 will be on Friday, June 10. For our 60th celebration the thinking has been to have our whole program on the campus, as has become traditional for reunioning classes. Tentatively this would mean gathering on Thursday, June 9, for lunch at Endicott House and "The Pops" that night. Friday would be about the campus with visits to points of interest, including the Historical Collections. On campus we would be guests of M.I.T. for dormitory lodgings, probably concentrated in the new McCormick House. Saturday would be about campus and Boston. Now thanks to **Bob Erb** we have a different suggestion. He writes, "Let's have a combination program as we had for our 50th — part campus, and then a real cozy time on Cape Cod." Or if we take his lead, we could leave, maybe by bus, Friday afternoon or Saturday morning for Cape Cod to spend the weekend. **Dick Loengard** agrees with Bob and further suggests that locations between Essex, Conn., and Providence be investigated. This is all tentative, so let's have your thoughts and suggestions.

Dick had already reported that **Curtin, Neuberg,** and **Seely** joined him at the '16-'17 luncheon in November and that he, Neuberg and Seely with three '16ers had attended the December lunch at the New York Chemist Club.

As of December 10, Treasurer **Stan Lane** reports a healthy over-subscription to our $500 dues "offering." Many thanks to all you payees, a high percentage of our active list. Your officers will endeavor to give you your money's worth.

Bill Hunter has been made a member of the Alumni Advisory Council. . . . When **Dutch Neumann** was back for the reunion he had a good visit with **Nelson Chase** and bought some of his water color paintings.

Dan Langdale of the Student Financial Aid Office writes, "We still have no information as to last year's Aldrin Scholar Owen Knox and his plans. I feel quite sure that he will return to M.I.T. to finish his last year and obtain his S.B., but we have yet to track him down.

"We have selected a replacement. Mr. Paul A. Lagace, from Lewiston, Maine, has been selected as the Class of 1917 Edwin A. Aldrin, Jr. Scholar for 1975-76. Mr. Lagace is a member of the Class of 1978, and has recently elected to major in the Department of Aeronautics and Astronautics. He came to the Institute from Cheverns High School in Portland, where he graduated first in his class. In addition to a heavy academic load during his freshman year, Paul participated in the intramural sports program, both playing and refereeing, and was active in MacGregor House government.

"Funds are sufficient once again to allow the support of a third student in addition to Messrs. Solis and Lagace. We have selected Alan F. Glombicki, a junior in chemical engineering. Alan hails from Chicago and, in addition to his academic work, has been a volunteer worker in the emergency room of the Cambridge City Hospital and is an officer in his fraternity."

Our July-August notes stated that a John Gulinello had been selected for scholarship help. This was later changed to Glombicki instead. These three men will share $5,250 about equally.

Third-year man Michael Solis, '77, writes to us as folllows; "At the very outset, I want to express my gratitude to the Class of 1917 for its invaluable assistance to me in pursuing an M.I.T. career. It is a pleasant surprise to find alumni who manifest interest in one's personal and academic life, past and present, and I appreciate the opportunity to write to you. Born and schooled in New York City, I later had the wonderful opportunity to attend a private school in Connecticut, Pomfret School.

"By the last year of my high school I seemed to have recognised my overriding interest in psychology and the scientific and engineering methods available for the comprehension and therapy of the mental faculty. Exposure to M.I.T. was an enlightening experience, for it was here that I discovered in more concrete terms the techniques afforded by the disciplines of electrical engineering, electronics, and computer science in the study of the human mind. This is my third year of study of electrical engineering together with the pre-medical program. I am now considering a medical career, and would like to go on to become a psychiatrist, because of my great interest in people — their minds and their society.

"I will be glad to respond to any questions or issue which you may wish to bring up. Thank you!"

Our December notes listed some of those who returned Reunion cards although they could not come. Even if there is no message, it is good to have the card. Here are more names: **Connie Coakley, Dick Whitney, Bob Gannett, Sam Creighton, Penn Brooks, Dick Lyons, Charles Miller, Ham Wood, Warren Tapley, Ray Brooks, Luther Lauer, Harry Wansker, Harold Perry, George Kittredge, Harry Fine, Phil Maher, Charles Plummer, Burling Wells, Alex Kenigsberg, Bill Tuttle, Chet Ames, Paul Woodward, Noah Gokey, Al Chase, Irving Fine, Francis Goodale, Charlie Abels,** and **Ray Blanchard.**

With regret the deaths are noted of **Frank H. Randolph** at Ithaca, N.Y., on October 22 and Capt. **Garland Fulton** at Bala Cynwyd, Penn., on October 24. — **Stanley C. Dunning,** Secretary, 6 Jason St., Arlington, Mass., 02174; **Richard O. Loengard,** Assistant Secretary, 21 East 87th St., New York, N.Y. 10028

Russia: Where Contrasts Still Flourish

In November of 1974, Frances and Pete Harrall, '18, journeyed to Russia with the International Platform Association. Their interesting account — too long to print in entirety — relates the customs: of promptness — "a seven o'clock dinner meant just that;" good but carefully-portioned meals; and the desire for consumer goods that Americans take for granted — one of their party was offered $50 for a pair of blue jeans, and children bargained their "treasures" for sticks of gum.

Contrasts still flourish in this country of state and collective ownership, and free education. There is the architectural splendor and museums of the past. The Army in the Kremlin — once only viewed by the aristocracy and now open to 3,000 people a day — displays the riches of the Czars ("a solid gold table fountain where a servant was necessary under the table to pump the water").

In historical Leningrad, they visited the Hermitage, formerly the Winter Palace, which houses one of the finest art collections in the world; the ancient churches with their beautiful interiors, still "functioning" to all *but* children so "the thread of the church is lessened until it no longer exists." But the Harralls were disappointed by modern Leningrad which was built rapidly after the vast destruction of World War II. It is mostly "shoddy high-rise apartments — these can be put up in about 21 days!"

If you'd like to read their complete adventure, write to the *Review* for a copy.

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As I write these notes it is the shortest day of the year. Twelve inches of snow fell in the last 24 hours — 12 inches more are expected in the next 24 hours — but it is that glorious season to exchange greetings of good will and prayers for peace. I am happy to acknowledge cards with newsy messages, intended for all of you.

From Rhoda and **Charlie Tavener**: "We had a wonderful visit at the reunion. Hope we can do it next year. We are going to Alaska to see Rhoda's daughter. Had a wonderful trip to Bavaria, Germany, but a little too short." . . . From **Bill Collins**: "Sorry I can't give you a travelogue as many classmates do. I have lived alone since my wife's passing on a year ago November. My cooking has not reduced my weight a bit. The other household chores are uninteresting. I spent three weeks with my daughter and her family in Colorado, a beautiful country. In June I went to Virginia to give my late son's daughter away in marriage. Outside of a weekend in Maine at my daughter's camp, I have stayed put. At 80 the desire to roam fades and one is satisfied to stay home."

From Dot and **Clarence Fuller**: "We were more than sorry to have missed Endicott mini-reunion, but Dot just wasn't up to it. In fact she's had a rather difficult year. She changed eye doctors early in the year and the new doctor got her fitted nicely with a contact lens in her left eye so she sould see clearly again. No decision yet about operating in the right eye. In April she had a series of angina attacks and still has to be very careful or there will be more. They're not fun! We've cut out all outside activities until we see how things develop. I'm pretty good as long as I take my digitalis pill every day!" . . . From Marion and **Herb McNary**: "Marion and I spent our third consecutive Thanksgiving in Bermuda. It's rejuvenating to go back to the scene of our honeymoon — and yours. Come to think of it the sense of rejuvenation probably accounts for the popularity of Class '18 mini-reunion and the fact that the *Review* consistently has the longest space — both due to you."

From Dorothy and **Granville Smith**: "We are grateful for good health during 1975 and for the visits of friends and grandchildren. Peter and Mark came down to Florida in March and Allison in April. We have a new boat to whizz down the Waterway or wend our way slowly through the labyrinth of canals on Siesta Key. In the Spring the perfume of the orange blossoms of the Royal Poinciana tree spreads across our lawn. In mid-June we left for Maine — this time by ship from Miami to Yarmouth, Nova Scotia, with our car on board, saving many miles of driving. The M/S *Bolero* was a real luxury ship and our three days aboard seemed all too short — with the captain's welcome-aboard party on one day and the farewell dinner the next! For the rest of the summer, we rented a cottage on Lake Androscoggin. There we enjoyed visits with D's family and friends, trips to the shore for lobster dinners and visits with friends in the New England area. We took the Auto-Train back to Florida at the end of September. The big event of the fall was D's birthday party for G in the form of a wine-and-cheese-tasting party, followed by champagne and birthday cake in the "penthouse." G's military activities plus college club meetings for both of us as well as the usual swimming, gardening, etc. keep us busy and happy."

From Frances and **Pete Harrall**: "From St. Basil's Cathedral in Moscow in December, 1974, life's pace has taken us from our beloved "Nepenthe" and six wonderful years there to a modest retirement rancher which shall be known as: "Halcyon House," 6235 Fernway, Baltimore, Md. 21212. With transportation only two blocks away and our church within easy walking distance we feel truly "settled in" for whatever years are left and whatever Fate decrees us. We are convinced that this is the right move . . . and the right time to make it . . . so we won't look back except at the depth of joy which your friendship has brought and continues to bring to us. Now as we approach this Season of Love we reach out in tender thoughts

to you, our friends, wherever you are and wish for you and yours the joys of the Holiday Season, with full measure of Health and Happiness in the coming year." . . . Holiday greetings arrived also from Hazel and **Sax Fletcher, Pete Strang,** Mildred and **Herb Larner,** and Hildegarde and **Fred Philbrick**.

I am indebted to Narcissa Chamberlain for a notice of **Samuel Chamberlain** — A Memorial Exhibition of His Drawings and Prints, under the Sponsorship of The Octagon, Washington, D.C. For your information The Octagon is a beautiful 18th century house which has long been the historical headquarters of the American Institute of Architects, of which Sam was an honorary member. This show will be moved to the Boston Public Library next spring or early summer. Some of you in the Washington area ought to see it soon — others of us will be able to view it in Boston later on.

Len Levine — my most able associate — is responsible for a most interesting story of what he does and thinks. I hope many of you will emulate him and do likewise. He writes: "Life begins at 70. In 1966 I was still pleasantly employed by the Federal Government as a Research Engineer at the U.S. Army Natick, Mass., Laboratories. I liked the job, my co-workers, the beautiful collegiate buildings and environment, and the salary which included substantial pension and other benefits. I eventually reached the mandatory retirement age of 70 and in spite of the fact that I was productive, in excellent health and seemed to have all my marbles, I was retired with so called 'honors.' I was given the conventional good wishes and cordial hand shake from a handsome two-star general, a fancy scroll describing some of my accomplishments, and a peppy cocktail party. Everyone seemed to be having a hell of a time but I personally felt as if I were attending a wake.

"Whereas I had worked closely for 11 years with a large group of scientists, engineers, and draftsmen I thought I would receive quite a few phone calls at home regarding my well being in retirement. My ego was sharply deflated when I received only two calls, both from ex-secretaries wanting to know where certain reports could be found. I then decided to forget living in the past and to get busy about the future.

"Gladys and I went to Florida to look things over and I became restless with the inactivity, the complaints, and aches and pains of the old timers and windy not-too-warm weather.

"Returning to Boston, I was hired as a teacher in a private vocational school of first year college level. I was accepted so quickly, in spite of my 70 years, that it took my breath away. However, I have a strong suspicion that the clincher was my M.I.T. degree along with being a Certified Professional Engineer and particularly because I was willing to work for a modest salary. However, a job of five hours a day and about 12 weeks vacation per year seemed interesting.

"Now, nine years later, I am on the same job. Much of my time is devoted to teaching drafting and blueprint reading.

"The school is a small compact vocational outfit of about 300 students ranging from 18 to 60 years old. Students are of all types and include many that are supported through school by various government grants. Some of the students are older men who are out of a job and training to become draftsmen, electronic technicians, or air conditioning mechanics. We also have students from foreign countries such as India, Nigeria, the West Indies, etc. Most of the students get placed at the end of the one year course although the last year has been tough.

"Teaching this group is an interesting challenge which I enjoy in spite of occasional frustrations. The most difficult teaching problem is the eternal one that is created by the considerable spread in ability, willingness to work, and effort of the various students in a class. The bright energetic ones go along rapidly with a minimum of instruction; the middle group responds favorably in most cases to strong intelligent teaching; but the slow and laggards and 'do-little' group require constant encouragement and individual attention. I try to help the last group as much as possible as I feel that if I can prevent them from dropping out and going on welfare or grabbing a gun I am also helping our highly vulnerable present-day society.

"I go over to M.I.T. about once a month to attend lectures on solar energy. I get a big kick out of the meetings and enjoy meeting top people from many big companies and colleges who are interested in this form of free energy. I am teaching some of the basic ideas in my own classes.

"Gladys and I still lead an interesting social life including some travel. I hope, Max, that I can send you another episode a year from now entitled, 'Life Continues at 80.' "

I record herewith the passing of **James Sullivan** as noted by Len Levine in the local newspaper notice.

James Sullivan died on December 2, 1975, in Lynn, Mass. He was a retired district manager for the Massachusetts Division of Employment Security. Mr. Sullivan was born in Marblehead and lived in Swampscott before moving to Lynn 40 years ago. A Navy veteran of World War I, he worked at the General Electric River Works for ten years before joining the state employment service. "The class of 1918 sends its deepest sympathy," writes Len Levine. "I played on the ball team with Jim at M.I.T. and later for the General Electric Co. in Lynn where I was employed. Jim was a nice fellow and we will miss him." — **Max Seltzer,** Secretary, 60 Longwood Ave., Brookline, Mass. 02146; **Leonard Levine,** Assistant Secretary, 519 Washington St., Brookline, Mass. 02146

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Thanks to the thoughtfulness of Paul Cardinal, '24, I have some heartwarming news of **Chuck Lawson,** who recently celebrated his 56th wedding anniversary in Naples, Fla., where the Lawsons have finally settled after a lifetime of travel. Chuck distinguished himself in both World Wars, ending service as a colonel. Between wars, he began a long career with IBM, and his work took him to no less than 22 locations. Mildred and he now reside at the Boulevard Club, and Chuck is active in the Naples Civic Association and the Naples Yacht Club. The Lawsons have three children; two sons graduated from M.I.T. and have notable careers in the electronics and computer industries.

At this writing, a few days before Christmas, your secretary's ancient heart has been warmed by greetings from the **Norrie Abbotts, Alan Burkes, Buzz Burroughs, Ed Ryers, Dick Gees, Bill Deweys, Stan Reynoldses, Lee Thomases, Art Merrimans,** and **K. B. Whites.**

A happy and healthful new year to you all! — **Harold Bugbee,** Secretary, 21 Everell Rd., Winchester, Mass. 01890

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Vina and **Ray Cooper** are moving from Long Island to 212 Medford Leas, Medford, N.J. 08055 on January 15. "The time has come for us to become residents at a retirement home, with lifetime medical care. This beautiful home is run by the Quakers." The Coopers entertained Ruth and **Irving Jakobson** and Jane and **Dayton Brown** early in September to celebrate Jake's birthday. Continuing a custom of many years the Browns and Jakobsons spent Thanksgiving Day together.

A good long letter from Assistant Secretary **Josh Crosby** brought me up to date on some of our Florida contingent. Josh says **Helier Rodriguez** chased him most of the way back to Florida from the Crosby's summer home in Maine. "I had just recently left when Helier tried to reach me by phone in Maine. . . . **Allen Addicks** asks about some people he had lost track of. . . . Our M.I.T. Club had its first fall meeting on November 12 and our class was represented by Beth and **Whit Spaulding,** Helga and **Jim Parsons, Herb Kaufmann,** Claudia and myself. . . . **Larcom Randall** had a heart attack in November. He was out of the intensive care unit. I was able to visit him in the hospital and found him in bed and in good spirits. . . . Claudia and I had our first bridge session at the Kauffmann's. Herb is quite busy as treasurer of the condominium association and as road commissioner for Siesta Keys. . . . Whit Spaulding and I are practicing up on our golf to take on **Royal Wood** when he arrives. **Dick Windisch** was in the hospital in Naples in November but was not seriously ill."

Your secretary recently had correspondence with Hugh Darden, Institute Secretary, about the new William Barton Rogers Pooled Income Fund. This Fund, which requires an initial gift of $5,000 to participate, will pay a lifetime income to you and your wife as long as either one you lives. It is hoped to pay a return of around 7 per cent. For those that may have planned a bequest to M.I.T. this is an attractive alternative and has the advantages of providing an income tax deduction and eliminating the amount of the gift from your estate.

Grant Miner in California was hit by an infection in October that laid him low for six weeks. However he is now back to normal and able to a little yard work.

Philip A. Nelles, Jr., of Stoneham, Mass., died on July 13, 1975 after a long illness. He had been confined to a nursing home for over a year. Phil interrupted his study at M.I.T. to serve in the U.S. Naval Reserve in 1918. In the second World War he was a major in the U.S. Army Ordnance. Shortly after graduation, he worked in the development department of Firestone Rubber, and then as an industrial gas engineer for the Mystic Valley Gas Co. He retired in 1961. He was a trustee of the Stoneham Savings Bank and a Mason. The sympathy

Vice Commander Raymond O. Bastien entertained the Club of Southwest Florida last fall with the history of the Coast Guard and its air and sea rescue operations. Accompanying him, from left to right, are: Granville B. Smith, '18, past President of the Club; Robert D. Butler, '32, President; Josiah D. Crosby, '21, Secretary; and A. Raymond Holden, '23, Treasurer.

of the class is extended to his wife Kay and his daughter Patricia Oram.

My college roommate, Hobart Fischer, '22, whom many in our class will know, writes from Daytona Beach that he had a coronary attack in October but fortunately it was a minor one and he was in the hospital only 16 days. The Fischers visited daughters in Ohio and New Hampshire during the year. They now have five great-grandchildren. . . . **Rufe Shaw** reports, "This year has been a honey — business has doubled, so have our profits, and we have a six-month backlog of orders. This past summer I had a kidney stone operation. It was worse than having a baby, or so I am told. I lost about 20 pounds which was good." . . . **Dorothy Wenick** wrote that she and her son Richard were leaving in mid-December for a month's visit with her other son Martin at the American embassy in Rome. She plans to spend some time in Florida this winter with a friend at Warm Mineral Springs. . . . Emma and **Al Lloyd** made their annual trip south in November to visit children in Arlington, Va., and Atlanta. They were spending Christmas with their daughter Barbara's family in Westwood, Mass. . . . Helen and **Bob Miller**'s Christmas card was another family portrait with 11 grandchildren — not a hippie in the lot. They were planning to spend two weeks in January at Marco Island, Fla., and hoped to make a date with the '21ers in Naples, Fla. . . . **George Chutter** writes that Marion has been having a number of health problems which they are trying to surmount but progress is slow. . . . Betty and **Dug Jackson** will be spending some time at Mt. Dora, Fla., this winter. — **Sumner Hayward,** Secretary, 224 Richards Rd., Ridgewood, N.J. 07450; **Josiah D. Crosby,** Assistant Secretary for Florida, 3310 Sheffield Cir., Sarasota, Fla. 33580; **Samuel E. Lunden,** Assistant Secretary for California, Lunden and Johnson, 453 South Spring St., Los Angeles, Calif. 90013

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In a card from Carlys and **Frank Kurtz,** they are pictured standing in their living room in Delray Beach attired in formal Florida garb. . . . Another family photo received is from Edna and **Bill Mueser** of Bedford, N.Y. Their first grandchild, Lisa, graduated with two degrees from Lehigh University in December. She is twenty and finished in 2½ years. . . . We also hope to see Madeline and **Parke Appel** in Venice, Fla., this winter. . . . The card from Katherine and **Mac McCurdy** has a lovely back drop in their home in Palm Springs in front of a huge fireplace.

Ronald G. Macdonald is still active as Senior Editor of the *South Pulp and Paper Manufacturer,* published in Atlanta, Ga. He is also an active member of the Rotary Club of Queens Borough in New York City.

The sympathy of the class is extended to the family of **Benjamin W. Thoron** of Washington, D.C., who passed away last April. He was Treasurer of the Protestant Episcopal Cathedral Foundation. . . . We also send sympathy to the family of **William E. Huger** of Valley Road, Atlanta, Ga.

A happy winter to you all — **Whitworth Ferguson,** Secretary, 333 Ellicott St., Buffalo, N.Y. 14203; **Oscar Horovitz,** Assistant Secretary, 3001 South Course Dr., Pompano Beach, Fla. 33060

23

Herman B. Swett writes, "In order to supplement my retirement activities, I now have a part-time position in the physical education department of the Pasadena Y.M.C.A., and I will be happy to welcome as my guests any members of our class who happen to come to this area. Just ask for Herman at the locker desk." Sounds great, Herman — you yourself must be in wonderful physical condition, perhaps better than many of us can still hope for.

On October 10 last Doris and **Pete Pennypacker** entertained at lunch at their house in Deep River, Conn., a party of eight — including Katie and **Herb Hayden,** Marge and **Tom Rounds,** and Helen and **Lem Tremaine.** The food was delicious, the fellowship fine, and the reminiscences of the 50th Reunion many and interesting. Briefly touched upon were possible plans for our 55th Reunion, with some consensus toward having it on the Cape again with optional attendance at Alumni Day (Homecoming) in June, 1978. Readers of this column are asked for comments and ideas.

We are sorry to report the death of **Frederick E. Bastian** of Niagara Falls, N.Y., on June 17, 1975. Fred was a native of Rochester, N.Y., attending local schools and the University of Rochester before entering M.I.T. He married M. Aria Van Houten of Rochester and had four children and fifteen grandchildren. His business activities included Production Manager of the Bastian Brothers Co., Heating Engineer with the Empire Gas and Electric Co., and finally Sales Engineer and Manager of Sales of the Carborundum Co. . . . Also we learn of the death of **Daniel B. Coleman** of Ferguson, Mo., on June 22, 1975. Dan was born in Poplar Bluff, Mo., and after attending Missouri University entered M.I.T. obtaining his S.B. degree in Business and Engineering Administration with our class. He married Dorothy Mumford of Columbia, Mo., and they had a son Dan and daughter Dorothy. He was General Superintendent of the Ruberoid Co. of St. Louis, Mo. . . . Finally, we are sorry to hear of the passing of **Douglas K. Severn** of Norwich, Conn., on November 19, 1975. Doug came to us after attending St. Paul's School and the U.S. Naval Academy, taking his degree in General Engineering with our class in 1923. After graduation he joined VanTassel Leather Co. and later became its President and Treasurer. Married to Alice Natalie, they had one child — a daughter; and for grandchildren, one girl and one boy.

From **William C. Gray** we learn of the death of his wife Helen C.(Lancaster) Gray on October 14, 1975. We send our sincere sympathy to all associated or concerned. — **Thomas E. Rounds,** Secretary-Treasurer, 990A Heritage Village, Southbury, Conn. 06488

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The paucity of Class news has led your Secretary to threaten a procedure attributed to the clergy, whereby a ten-year-old sermon is resurrected from the files in order to avoid the effort and monotony of preparing a new one. The proposal was to digest from 1967 my "Prostatic Thesis." This morsel is a daily description of the procedures and my feelings during a 12-day hospitalization for a retropubic prostatectomy — a rare recounting, from a patient's point of view, that has proven most interesting to medical students and interns.

However, a call to **Clint Conway** in Clearwater, Fla., has saved the day with news that he and Allora were fascinated by their month's stay in Spain, including Madrid and sightseeing the Basque country from their headquarters in Torremolinas (can't find it on my map) on the Mediterranean Sea. They found no visible unrest in Spain but witnessed a bombing in France.

Prices appeared to be slightly lower than in the United States.

Samuel J. Helfman writes on an Alumni Fund envelope, probably from Baton Rouge, "Although I retired from Barnard and Burk, Inc., consulting engineers (as Executive Vice President) in 1969, I am still active as a consulting engineer (self-employed). My specialty is the preparation of engineering and economic feasibility reports on public utilities and work projects. My hobbies are gardening and golf (at least it looks like golf). I am also active in Jewish Welfare Federation work." Sam originated in Beantown, U.S.A., graduating in electrical engineering. He was business manager and then general manager for the T.C.A. handbook.

The Engineers' Council for Professional Development has designated **Harold L. Hazen,** Dean Emeritus of the M.I.T. Graduate School, as the recipient of its 1975 L. E. Ginter Distinguished Service Award, presented during the 43rd annual meeting of the Council on October 5 in Kansas City. It recognizes outstanding contributions to the engineering profession through work in Council-related activities. Dr. Hazen was chairman of the Council's Engineering Education and Accreditation Committee from 1954 to 1956, and he was primarily responsible for translating into action the recommendations of the 1955 American Society of Engineering Education "Evaluation" report. . . . **Hoyt C. Hottel,** Professor Emeritus of Chemical Engineering at M.I.T., has received the 1975 Royal Society Esso Award for the Conservation of Energy, for his contributions to the science and technology of solar energy collection. The award was presented to Professor Hottel on December 1 — a gold medal and £500 sterling.

Herb Stewart has increased his retirement activity by lecturing, in his electrical field, to graduate students at Worcester Polytech. In the near future, he will be training some visitors from Indonesia as part of a Charles T. Main contract to engineer a power system and to train the administrative eschelon. Herb conducted 12 two-and-a-half-hour lectures on "Surge Protection and Protective Relays" which concluded December 17. With his usual thoroughness, he required homework papers as a measure of output and intake.

We have greetings from Eleanore and **Bill MacCallum** of Cotuit, Mass.: "Since Florida, we have been right here on the Cape. In December we are celebrating our wedding anniversary with a week in Bermuda to recall our December honeymoon there. Our plans are for California, Arizona, and probably Hawaii this winter."

A last-minute blurb from Clint Conway — "The fourth 1924 Florida Fiesta is being planned for Puerto Rico the latter part of March, 1976. **Al Roig,** who extended the invitation last year, regrets reneging, but circumstances beyond his control have arisen in the family. Details are not available at publication time. Information will be mailed to all Florida '24 alumni and others who attended the last Fiesta." Other interested classmates should ask for information by writing Clint Conway, 805 Maximo Ave., Clearwater, Fla., 33519; phone 813-726-3625. — **Russell W. Ambach,** Secretary, 216 St. Paul St., Brookline, Mass. 02146; **Herbert R. Stewart,** Co-Secretary, 8 Pilgrim Rd., Waban, Mass. 02168

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The class held an impromptu reunion at the December meeting of the Alumni Advisory Council. In attendance were **Jim Howard, Ed Kussmaul, Courtney Worthington, Will Gardiner,** and your secretary. We had a most pleasant evening together.

The rest of the news for this month is bad. Ed Kussmaul heard from **George Washington** that **Jim Evans**' wife, Rose, died suddenly on November 16, 1975. Those of you who were at the reunion have, I am sure, pleasant memories of meeting her on that occasion. . . . A note from the Alumni Records Office brings word of the passing in July, 1975 of **Edwin L. Harris** at his home in Ross, Calif. Ed received his S.M. in chemical engineering with our class.

Finlay G. Cameron died on November 4, 1975, at his home in Coronado, Calif. Fin was a native of Alberta, Canada, attended the University of North Dakota, and obtained his S.B. in electrical engineering with us in 1925. He retired in 1968 as vice president of the Central Illinois Electric and Gas Co. after 30 years service with that company. During 1968-69 he managed the Saigon Power Co. in South Vietnam for Commonwealth Associates. He was a Commander with Navy Construction Battalion in the South Pacific during World War II. Finlay at the time of his death was Chairman of the Coronado Senior Affairs Commission, a volunteer driver for the Meals on Wheels program, a member of the San Diego Sailing Club, and of the Graham Memorial Presbyterian Church. He is survived by his widow, two daughters, and five grandchildren.

The *Providence Journal* reported the death of **Philip A. Welch** on September 20, 1975 at the Rhode Island Hospital. Phil was born in Providence, R.I., and had lived in Warwick for the past 27 years. He received the B.A. degree from Brown University in 1923 and the S.B. in Course XV in 1925. Prior to his retirement in 1968 he had been employed by the B.I.F. Industries for 26 years. Phil was a member, trustee and treasurer of the former Plymouth Congregational Church of Providence and a member of the Edgewood Congregational Church of Cranston. He is survived by his widow, a sister and a brother.

Perhaps some classmate can clear up a mystery. The Providence, R.I., *Bulletin* reported the death of Frank M. Gookin on September 14, 1975. The paper noted that he graduated from M.I.T. in 1925. His field was electrical engineering. Your secretary has no record of a classmate by this name. Do any of you remember him? — **F. Leroy (Doc) Foster,** Secretary, 35 Woodland Way, P.O. Box 331, N. Chatham, Mass.

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It's mid-December at Pigeon Cove, and delightful. The "Crazy Greek", a brilliant yellow lobster boat, is hauling traps about 100 yards off shore. Ruth is resting as prescribed after one of the new knee operations for arthritis (stainless steel and polyethylene replacing worn cartilage), so I have the living room to myself with notes and clippings spread all round my chair. Yet I plan to digress from the usual class notes pattern and discuss education at M.I.T. as we heard about it at the recent Alumni Officers Conference.

Chancellor Paul Gray talked about the atmosphere of the Institute as a learning community and the undergraduate curriculum. I have since talked with him about certain aspects of his talk and it is only this small segment that I want to pass along to you. Much of his discussion was based upon the Alumni Survey of 1974 where, for example, one alumnus commented: "I think favorably of (M.I.T.) from an educational and research standpoint, but I found it an impersonal, cold and unfriendly place. . . M.I.T. was not much of a place to be in terms of lifestyle, but I am still capitalizing on what I learned there. It was extremely rewarding but it was not a very happy place to be." Paul goes on to comment on this: "what is it about M.I.T. that fosters these perceptions? And, more importantly, what can be done to change the reality? We owe it to ourselves and to future generations of M.I.T. students to ask what extent these personal costs are necessary. Must the bitter go with the sweet? If not, or if not so much sacrifice is necessary, what can be done to alleviate it?" He goes on to observe that M.I.T. has always been a science-based institution — sustained high levels of achievement are not just admirable — they are crucial to survival and there is little room for the academic dilettante, no matter how sparkling or brilliant he or she may be.

Furthermore, the Institute attracts young people who are already exceptionally able — many undergraduates come here predisposed to be intense, academically-oriented loners which for some the environment that rewards academic excellence reinforces.

The segment that these comments lead up to is what impressed me most and what I am really calling to your attention. "The faculty of the Institute do not, for the most part, regard the *classroom* instruction of undergraduates as their primary mission, nor do they receive their principal professional satisfaction and recognition from this activity. Lest I be misunderstood in this regard, let me expand a bit. The teaching that masters are inspired to centers on learning by a few enthusiasts. The age and experience of those enthusiasts matter little. The master teacher wants to share the excitement and satisfaction of what he or she is *doing*. This sharing is teaching in its purest and most effective form . . . . for most of the faculty, most of the time, formal instruction, such as that which occurs in the lecture hall or classroom, provides neither the intimacy nor the coupling to one's personal intellectual frontiers that are essential to highly effective teaching. If a faculty member's encounter with an undergraduate is centered on mutual intellectual interests and takes place on a scale that encourages sharing, personal relationships of quality and meaning naturally follow."

In response to my request for further clarification Paul wrote me a letter from which I quote: "The short half-life of scientific and engineering knowledge requires that we educate students to achieve intellectual self-sufficiency as early in their careers as possible. That is, our objective should be to bring them to the threshold of self-renewal or of educational independence so that they no longer need rely on formal educational processes of the kind they experience as undergraduates. Because current knowledge is so ephemeral,

there is no responsible alternative to this approach to education. One way of accomplishing this objective (and by no means the only way) is to put students in contact with 'senior learners' (i.e., members of the faculty) who know how to respond when faced with unfamiliar situations, with new knowledge, and with questions that have never been asked before, and to thereby transfer that understanding to students by the informal process of close association on problems of deep interest to both the senior learner and the 'junior learner' (i.e., the student)."

In a recent telephone conversation with classmate **Al French** I mentioned Paul Gray's talk and how M.I.T. is striving to educate a student to educate himself so this can become an ongoing process throughout life rather than simply providing an "education." Al's comment was "I thought that was what M.I.T. always did. . ." With my inadequately worded and very brief summary not getting across to Al I felt it was a subject of sufficient interest to all to devote this issue of notes to it again in summary form. My observations are that M.I.T. is always a jump ahead and since education is its real reason for being in business I am excited that these developments are being achieved. A more complete summary of Paul's discussion was prepared by John Mattill, editor of *Technology Review* and appears on pages 100 and 101 of the December, 1975, issue. I also have the entire 14-page talk and will be happy to send a copy to anyone interested. — Now the yellow lobster boat is coming back across the bay heading for Pigeon Cove Harbor with his catch as the shadows get longer which means we must say cherrio until next month. — **George Warren Smith,** Secretary, P.O. Box 506, Pigeon Cove, Mass. 01966

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Frannie and **Jim Donovan** join Florence and me in thanking the many classmates who sent us their holiday greetings: Betty and **Dud Smith** reported all's well in the family and told of their own travels last summer in Portugal, Spain and Morocco. They liked Morocco best because it was so different from anything they had visited before. . . . **Vic Decorte** and Alice returned in November from a long visit in Europe (Italy, Switzerland, France and mainly Belgium), then visited their family in Massachusetts. . . . Last year (1974) Louise and **Ernie Knight** were in the Orient over the year-end holidays on one of their freighter cruises which they find so enjoyable. Although more than busy already, Ernie has taken on the job of selectman in his town of Raymond, Maine. On September 28, Ernie's neighbors and friends gathered to help celebrate his 70th birthday.

During the early part of last summer Olive and **Newt Foster,** along with his brother and wife, took a 12,000-mile, nine-week automobile trip across the United States to the Pacific Coast and into Canada. They used a station wagon and a 20-ft. trailer and stayed mostly at camping grounds. . . . **Frances Myers** tells us that she has had a happy year and will continue to stay at her present home as long as she can drive her car. Enclosed was a memorial gift to the Class Gift Fund as "a token of Carl's affection for M.I.T." . . . Peggy and **George Mangurian** report that they went to Japan last May (With Madeline and **Hal Porter**), and on a two-week trip to Spain. While in Seville they saw **Hector Hagedorn**. . . . Hal, writing separately, said that they had toured Mexico in 1971 and attended the M.I.T. Fiesta in 1973. For this reason he did not expect to attend the 1976 Fiesta.

Maury Beren and Rose will not be attending the Fiesta. However, they and several other '28ers and M.I.T. people at Palm Beach, Florida, and vicinity plan a separate mini-reunion for that area. Some of the others are **Sid Brown,** Barbara and **Gordon Collins,** Edythe and **Dick Rubin.** This is an excellent idea. We hope that others will follow the example and set up such a meeting wherever '28ers can arrange to gather. We would be delighted to have your thoughts on the matter and news coverage of the occasions as they occur.

With deep regret we must report the deaths of three classmates. Sympathy on behalf of the class has been expressed in each case: (The Rev.) **John C. McCune** died on November 1, 1975. His life work was in the Christian Ministry which he served until the time of his death. We talked with his wife, Marjorie, who told us that John had been somewhat ill for the last three years. . . . **John B. Russell, Jr.** died suddenly on August 11, 1975. John retired three years ago as Dean of Engineering, Clarkson College of Technology, Potsdam, N.Y. We learned from his wife, Mary, that his health had been good and there was only a little indication of trouble just prior to his death. . . . **Robert N. Tucker** died June 29, 1975. His wife, Ruth, said that since retirement from the Division of Electricity, City of Columbus, Ohio, Robert had enjoyed life — especially his hobby of farming. His death was quite unexpected. — **Walter J. Smith,** Secretary, 37 Dix St., Winchester, Mass. 01890

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A note from **George E. White** states, "We had a great summer visiting good old New England, spending most of our time in New Hampshire and Mt. View Lodge in Whitefield. On our way back, we went through your lovely area (Hampton) and Rockport, Maine. We are now living in Naples, Fla., permanently, where the fishing is terrific. Wish my golf was as good. Best wishes and good health to all our classmates." . . . **William F. Jenkins** has moved to Manvel, Tex., his country place, to live permanently, which is 22 miles south of Houston. "I very seldom see any of my M.I.T. classmates," he continues, "though I did get to hear **Harold Edgerton** talk in Houston last month. Harold helped me with my oscillograms while I was working on my thesis; and in the background of one of the pictures I had in the thesis were some of Harold's earliest stroboscopic experiments. He seemed to get a big 'kick' out of seeing it."

Audrey G. Harms has sent a note stating that her husband, **Nicolaus L. Harms** passed away suddenly on November 16, 1975. "We had stopped in to see some of the brothers of 'Kappa Sigma' in their new home late in August of this year and he thought it was lovely." . . . A note from the widow of **Bernard B. Brockelman** also announced his death on August 26, 1975.

One of the featured speakers during the 96th Annual Winter meeting of the A.S.M. on December 3 was **Hunter Rouse,** Carner Professor Emeritus, University of Iowa on the "Origins of the Francis and Pelton Turbines." . . . **Joe Green** and his wife Doris will be spending winters in Florida starting in December, 1975. They will welcome any '29ers who might be in South Florida. Their address is: Rossmore Coconut Creek, 2709 Nassau Bend, Coconut Creek, Fla. 33066. . . . I received a note from **Wally Gale** confirming his reservation for a committee meeting for December 9, at the Faculty Club, M.I.T. It reads, "Dear Karny: With a son who comes home once a year from East Africa one would think that his homecoming would not interfere with Class '29 functions. So far, it has made us miss our 45th Reunion and now Joan and I split our time between our son and the dinner at M.I.T."

Kenneth G. Garside has retired from his usual profession and has acquired a new job, teaching in the area of the Environment at the St. Andrew's Episcopal School in Boca Raton, Fla. . . . **Eric A. Bianchi** writes, "The years roll around mighty fast at our age. I keep busy between some consulting chores and golf. We are spending more time in Florida and expect we may move there shortly. We shall be looking at this problem in early 1976. We are just back from a great visit with the Gales at Melvin Village. The foliage was superb and the weather delightfully warm. Kay joins me in sending our regards." **Frank Mead** and his wife Mary have already left (December 10) for their winter quarters, 530 Haki Ct., North Port Charlotte, Fla., and they would welcome '29ers to visit them. Frank has joined the M.I.T. Club of S.W. Florida and he plans to take part in their programs during January through April. He has had a busy summer, golfing, gardening, claming, quahoging, oystering, and fishing. He also has seven lobster traps which supplied the Meads with plenty of lobsters. Frank was elected as vice president of the New Bedford-Fall River-Providence M.I.T. Alumni Club. He is also active in many other Alumni affairs, such as Alumni Advisory Council, Corporation Development Committee and of course chairman of our 50th Reunion Gifts Committee.

Frederic Celler, who has been active in Franco-American activities, was recently elected as president of the American Chamber of Commerce in France. He is also vice chairman of the Bicentennial Committee for Americans in France. Frank served in Naval Aviation from 1941 to 1947, mostly in the Pacific. From 1947 to 1961, he was a corporate officer and a director of several companies, charged with their development and reorganization. In 1961 he joined AMP Inc. (electrical and electronic connectors) and was elected President and Director General of AMP de France (a subsidiary). He directed its successful evolution until his retirement last fall. Currently, he is an international consultant for AMP Incorporated and also director of other Franco-American industrial companies. In 1971, in recognition of the civic activity in Pontoise by AMP de France, the French Government designated him "Officier de L'Ordre National du Merite." . . . **Gustav A. Stein, Jr.,** writes, "Dear Karny: I now have four birthday cards from the class of 1929 in as many years — all in my unanswered file, so you can see how chagrined I am. . . . My son Nick and

my daughter Joanne have moved to Lighthouse Point and Pompano Beach, just seven miles from me. This is the first time since they have grown up that we have lived closer than 3,000 miles apart from each other. It has been an entirely different life for me, for they treat the 'Ol' man' much better than ever before. All the best to you and the rest of our classmates." — **Karnig S. Dinjian,** Secretary, 6000 N. Ocean Blvd., Apt. 14-E, Fort Lauderdale, Fla. 33308

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Sorry about the lack of notes in last month's issue, but we really hit the bottom of the barrel. Not even an Alumni Fund envelope came in.

We continue to receive delayed reports concerning retirements. **Dan Walker** retired in 1971 from the Naval Ship Engineering Center in Washington, D.C., where he was a mechanical and marine engineer. He and his wife live in Sun City Center, Fla., in the winter and have a summer home in Center Harbor, N.H. . . . **Charles (Chuck) Twelves** has retired as Assistant Vice President-Engineering of the Pacific Northwest Bell Telephone Co., where he was on the headquarters staff. He and his wife have two daughters and four grandchildren and live in Walnut Creek, Calif. . . . **Bill Waite** retired in 1971 after 20 years as a chemical engineer with du Pont. He says he enjoyed building chemical plants but has enjoyed his years of retirement even more. The Waites spend summers in Maine and Vermont and winters in the Florida Everglades. They have four children and seven grandchildren. Incidentally, I am now authorized to disclose that Bill was the classmate who, as reported in the October/November notes, chose a hot dog rather than a lobster at the clambake at Chatham Bars last June. It seems that Bill's aversion to seafood arises out of the fact that he ate so many codfish cakes at Walker Memorial cafeteria during his M.I.T. days; he says he has never again touched any kind of seafood.

Joe Twinem is a management consultant in the field of civil, geological, and mining engineering. He operates under the firm name Lloyds Investment Service from his home in Cripple Creek, Colo. The Twinems elder daughter, Carol, attended the University of Colorado, the Sorbonne, and Johns Hopkins School of Advanced International Studies; she is now an international and industrial economist. The Twinems have spent extended periods of time overseas, including four years in Japan, four years in Australia and six years in South Vietnam. . . . **Wes Wedemeyer** is still active in the architectural firm of Wedemeyer-Cernick-Corrubia, Inc., in St. Louis. In addition to being the firm's Board Chairman, he is President of an organization called Planning and Construction Consultants, Inc.

We have received a notice that **Graham Walton** died suddenly of a massive heart attack on June 26, 1975. Graham was born in Gambier, Ohio, and graduated from Kenyon College with a B.S. degree in mathematics before coming to M.I.T. He received his S.B. in sanitary engineering from M.I.T. and later obtained M.S. and Ph.D. degrees at the University of Wisconsin. During his early post-college years he was an instructor in civil engineering at South Dakota State School of Mines and instructor in hydraulic and sanitary engineering at the University of Wisconsin. During the years 1943 to 1970 he was a commissioned officer in the U.S. Public Health Service. After assignments with the Public Health Service in Denver, the Public Housing Authority in San Francisco, and as consultant sanitary engineer with the Federal Bureau of Prisons in Washington, he moved to the Taft Sanitary Engineering Center in Cincinnati in 1948, from which he retired in 1970. He was an active member of the American Water Works Association and authored an impressive list of professional publications and technical reports in the field of water purification. — **Gordon K. Lister,** Secretary, 530 Fifth Ave., New York, N.Y.

Fiesta!

Last reminder — the 28th annual Fiesta in México of the M.I.T. Club of México City, the oldest alumni club outside the U.S.A. Three days of "Old México" events on March 11, 12 and 13 in México City and nearby towns — a full program for your pleasure with an added surprise attraction. Then a post-Fiesta trip to Morelia in colonial México, with a tour of the Lake of Pátzcuaro and the island of Janitzio, famed for its butterfly-net fishermen. This is hummingbird country, renowned for native sweets, olive trees and items of straw — and gorgeous scenery you and your wife will enjoy. Write now for full information to the M.I.T. Club of México City, Apartado Postal 31, Fracc. La Florida, Estado de México, México, or telephone 562-17-73. — Carole A. Clarke, '21, Executive Secretary in the U.S.A., M.I.T. Club of México City, 608 Union Ln., Brielle, N.J. 08730

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Because of the necessary long lead time between the time these notes are written and the time they appear in the *Review*, it is difficult to keep you up to date on plans for our 45th Reunion. As of the middle of December, Jan and **Larry Barnard,** our Reunion Co-chairmen, furnished the following news concerning a meeting held November 18. The Reunion being on campus, accommodations are available to us at no cost. Burton House has suites of one, two, and three bedrooms with a bath. Not everyone can have a suite entirely to himself, but it was suggested that when members sign up, they have a chance to ask for particular suitemates, or if they prefer, request a reservation at a nearby motel. Replies to the October 22 letter include 119 members, plus wives in most cases, who definitely plan, or hope, to come. The program now includes a class banquet Wednesday night, a dinner, possibly on the waterfront, Thursday, followed by Pops at Symphony Hall, and Alumni Day, now renamed Technology Day, will be Friday. Plans for the Reunion are well in hand — and a good time should be had by all. Plan to attend! Jan and Larry report that they had a grand time during their recent six-week trip driving around Great Britain and Ireland.

Cliff Walker reports that he retired in March, 1972, from the Port Authority of New York and is trying to find a place to enjoy his retirement. He sees **Gabe Cristofalo** about twice a year and, while working, renewed old times with **Marcel Aillery** and **Charles Broder.** He was sorry to have missed the Mini-Reunion in Mexico due to his "on job" injuries. . . . **Claude Machen** seems to like Florida and writes that he is looking forward to a great 45th Reunion on campus. Speaking of Florida, unless our plans go astray, we should be moving there during 1976. We have just returned from a three-week trip there — and it looks good to us. . . . **Lou Evans** writes that he retired from Mobil research and development in November, 1973, and is spending his retirement in leisure, traveling, golfing and also doing some volunteer charity work.

News of **Arthur R. Partington**'s death on March 18, 1975, has just been received. Our sincere condolences to his wife, Evelyn, and family. — **Edwin S. Worden,** Secretary, 35 Minute Man Hill, Westport, Conn.; **Ben W. Steverman,** Assistant Secretary, 260 Morrison Dr., Pittsburgh, Penn.; **John R. Swanton,** Assistant Secretary, 27 George St., Newton, Mass.

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I hope **Don Whiston**'s annual message with respect to the Alumni Fund and our 45th Reunion in 1977 is receiving your special attention. Let's give Don some real support in both areas.

The early Christmas mail produced annual greetings from Midge and **Bill Pearce,** Dorothy and **John Finnerty,** and Doris and **Don Gilman.** Incidently, Don Gilman is retiring from active executive duties with the Warren Pump Co. but expects to do some consulting work with the organization. . . . **Raymond K. Flege** retired in 1972 as a professor of textile engineering and has been on assignment overseas ever since for the International Executive Service Corps. He reports that there never seems to be enough time for his many interests.

Oliver H. Scharnberg died October 10, 1975 at the New England Deaconess Hospital after a long illness. He had served as a financial consultant to numerous companies, colleges and institutions. Our sincere sympathy is extended to his family. — **John W. Flatley,** Secretary, 6652 — 32nd St. N.W., Washington, D.C. 20015

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No first billing this time; there are too many of the faithful, for a change. **Louis Alpert** writes that he cannot make the Fiesta because he must be in San Francisco all week, and he deplores Mexico's most unfortunate U.N. vote on the Israel issue. Louis took an extended tour of the Scandinavian countries with his wife last summer, and really did enjoy it. . . . **John Rumsey** toured in the U.S.S.R. last summer — all strictly pleasure, no business. The Rumseys have moved, but are still in Bloomfield Hills; changed lakes or something. . . . It appears that **Otto Putnam** will make the Fiesta, but only directly after a trip to the Canary Islands so that he will have to attend alone as

Mrs. Putnam can't take both, successively.

Harry Summer writes at some length on legal paper, in longhand, so this is a translation: They have spent four of the last five years on Mexican winter vacations, so this year they are delighted to attend the Fiesta. Harry's #1 son is a practicing lawyer, #2 is in medical school, and good wife, Cecile, is in fine health, and able to follow Harry on his many travels.

Bob Dillon sends his regrets re the Fiesta. I gather that neither he nor his wife are high altitude enthusiasts, and they have been to Mexico City. Bob lives in La Marque, Tex., which, I decide, must be on tidewater. . . . **Ivan Getting** writes that his wife can't take high altitudes, but that he will make every effort to be among us if he can find time in his busy schedule as president of Aerospace.

Walt Duncan finds that he can't be two places at once, and he has already arranged to be in Hawaii to visit his son. They see their son only every one or two years, so M.I.T. loses in favor of family obligations. Walt has been retired since last April, but finds himself busier than ever with many civic activities.

We have another dang good letter from **Hollinshead T. Martin,** usually yclept Gus. Now, Gus has explained the nickname, and it goes like this: with the name Hollinshead, what the heck would you do? I have speculated on what the "T" stands for and have tentatively arrived at Terwilliger. Gus reports: "We have rented our house on Casey Key (Sarasota) for the months of February and March, so we are already studying the merits of various trips." Now, Gus, you may not know it, but the M.I.T. Club of Mexico City has arranged a top notch three-day trip following the Fiesta. It has gone over well, though I have not taken advantage of it. So, Gus, hasta la vista, and I will sure see you!

Art Hungerford says there is a better than average chance that he and his good wife will come to Mexico. My guess is that the Hungerfords will be with us and bring part of the family along. Art sends a slide of our 20th at Wentworth-by-the-Sea, in which we both recognize **Dick Morse** and **Bob Forbes.** . . . **Cy Hapgood** has to turn us down on account of a long cruise in February, and plans for a vacation in Delray Beach in April; I guess he has to work through the month of March.

A letter was, at my request, sent to every living classmate who ever was a 1933, including drop-outs and people who have not kept in touch with us. I do not receive too many responses from this last group, so a note from **Mark Kalustian,** who dropped out in his senior year, is most gratifying. Mark is with Stone and Webster, and will soon retire, after 35 years of continuous employment. "I am a little fellow, living a low-key life, at peace with the world, with no burning ambitions." Mark lost his good wife of 32 years, four years ago. He loves to travel, and is mostly interested in eastern Europe; Vienna most of all, with Budapest a close second. He collects rare books and fine European china. In his library is a large collection of Americana.

Bill Huston reports that after he retired from N.A.S.A., he did not wish to stop working, so he took a new job with O.A.O. Corp. of Beltsville, Md. The new job is closely related to the work Bill did at N.A.S.A.: weather and climate research. It appears that Dot also has a job, and hence the Hustons are only 99 per cent sure of making the Fiesta. Bill and his family have visited with us in Florida. May I add right here, that Leona and I appreciate no end having '33 callers and we remember them.

Ruth and Bob Timbie during one of the jaunts of the 1970 Fiesta (left), and riders at the Cherreada.

Ellis Littmann, our Executive Vice President, writes that he has a meeting in southern California the week following the Fiesta, which makes it a little hard for Ellis to make up his mind. But, knowing Ellis, I do not doubt that he will be with us. Ellis seems not to be sure why I have urged our class officers to make the big event, so perhaps a word here would help. Though the Mini is non official, the presence of officers would strengthen our "point with pride" ego. No other significance, Ellis. Though it is well known, I wish to add that I can think of no one who has done more for the Institute and his class than Ellis. By this I do not mean just financial help; I mean the giving of his time, and of himself, above the call of duty. We could use more Ellises, but we are thankful for the one we have.

A nice note from **Bob Timbie**: "Our visit to the 1970 Fiesta was one of the most fascinating sojourns we have ever taken, but, Ruth has her heart set on a trip to Brussels, about March, to see the Timbie daughter and the grandchildren. So, the Fiesta is out for this year. Father Time caught up with me and I retired October first. **Ray Smith** and Olive dropped in the other day, and reported that he, **Joel Stevens,** and **Andy Regan** have all retired. They are all fine except that Andy has a mysterious balance problem (probably inner ear, what?). The Smiths plan to visit their daugher and granddaughter in Kenya later this winter. For me, and Mexican archaeology, they excavated both my sides and removed eight kidney stones, but the hieroglyphics are obscure so no story may be invented. Am getting some house fixing done, as well as some stone finishing (not the kidney stones), so we expect to be trailering to central Florida very soon."

We have a miniature press note announcing that **Dick Morse** would speak at the Harvard Business School Club. . . . We have only two Alumni Fund capsules this time: From **Bill Sheppard,** "I'm a case assigner for the Manasota Chapter of Score (Service Corp. of Retired Executives). Some 300 applications for small business counseling this year." . . . **Carl G. W. Swanson** writes: "Have been retired for 20 months, and thankful for good health and all the blessings of life. . . . Working on our Connecticut house, purchased June 15, 1973. Enjoy reading fiction, biography, and detective stories; also working in the garden . . . wife Katherine does volunteer hospital work once a week." . . . And a card has come from **Ellery Clark.** They have already made their reservations for the mini, and Fiesta, "Retired last May, and at once mounted a trailer, and toured for 7½ months in the American and Canadian Northwest. Bought a lot in the Yucaipo Land Yacht Harbor for Airstream Owners, and are in the process of purchasing a 24 × 60 ft. mobile home."

See you good folks at the Fiesta come March. Please note that an effort like the Mini does something for everyone: the M.I.T. Club of Mexico City, the Class of 1933, and mostly, the Institute. — **Warren J. Henderson,** Secretary, 1079 Hillsboro Beach, Pompano Beach, Fla. 33062

34

These are discouraging notes to be writing just before Christmas as they are largely concerned with the losses of classmates. The first is one we share with 1933 since **Norman Levinson** received his B.S. in that year, an M.S. in 1934 and Sc.D. in 1935. He had joined the Institute staff in 1937 and by 1949 was promoted to full professor. He was acting head of the Mathematics Department in 1951 to 1952 and head of that department from 1968 to 1971. In 1971 he was appointed an Institute Professor. Dr. Levinson conducted theoretical and experimental research on underwater ballistics during World War II and received many awards and honors in the field of mathematics during his career. His death came on October 10 and he is survived by his wife, two daughters, his mother, and a sister.

Our second loss is that of **Emerson P. Hempstead** who was living in Greenwich, Conn., when he died on December 3. Beyond this I have no information.

Anthony Savina, '30, was kind enough to send me a clipping on the death of **William Timmerman** on October 22 in Stamford. Bill was a sales engineer with the Torrington Co. and a retired Lieutenant Colonel of the U.S. Army. In addition to his wife, Anna, he leaves his mother, a son and two daughters, a sister and two grandchildren.

Ralph Cross Tackles the Business Cycle

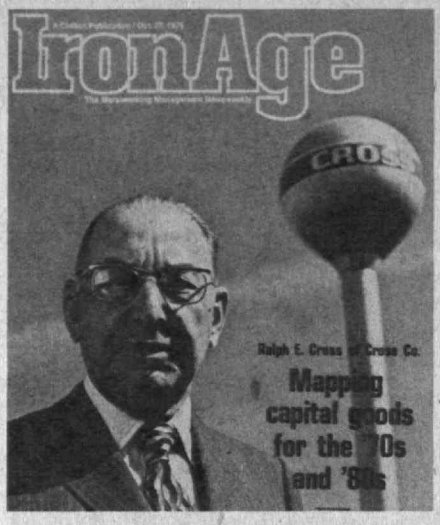
How to bring a company through cycles of recession and prosperity, through changing patterns of demand and supply?

Planning and flexibility are the answers of Ralph E. Cross, '33, whose picture landed on the cover of *Iron Age* magazine this fall when his company — Cross Co., with headquarters in Fraser, Mich. — made new records leading the machine tool, capital goods industry out of its 1971 recession. "One of the capital goods builders which is already designing the company for the pull into the 1980s," said Keith W. Bennett of *Iron Age*.

Long lead time is one of Cross Co.'s assets — the backlog is something over $70 million, and Mr. Cross capitalizes on it. "That long backlog gives us more time to react to new recession. We can bring in new products. We always have something on the drawing boards, anyway. We have a big technical staff. We're able to swing engineers from products hit by the slowdown into new product work," he told Mr. Bennett.

Planning is an integral part of the business, Mr. Cross told *Iron Age*. "We've been into cost forecasting as much as 15 years ago. . . . Forecasting labor cost, materials cost, services cost, and capital consumption. There's a steadily greater need for this in our industry.

"We can see business cycles continuing into the decade ahead. And even the econometric models can't be counted on to fully predict the turns."



Overseas business has helped Cross Co. to smooth out the peaks of domestic business cycles — "the best single counterforce . . . to beat the cycles," Mr. Cross told Mr. Bennett. "When things were off in the U.S., business was strong in Germany. Now the reverse has been true, (but) it's pretty good in the United Kingdom."

Mr. Bennett finds Cross Co.'s flexibility mindful of " 'the fast reaction capability' of electronics design groups of a decade ago, able to build special government equipment on a limited-time, design-from-scratch basis." — *J.M.*

To all the families of our classmates who have suffered these losses I would express the fullest sympathy of their past friends and fellow students.

In a more cheerful vein I have an Alumni Fund note from **Rodolfo Gonzalez Garza** who says: "I am retired — hobbies — horseback riding, tennis, traveling. Would like to receive fellow alumni who may come to Monterrey, Mexico with advance notice by mail or phone since I travel a lot. My phone 462027-484775." If you might be going that way and would like to write ahead, Rodolfo's address is E. Zola 7430 Bisdado, Monterrey, N.L.

Reading between the lines, I take it that **William "Duke" Haseltine** will be retiring from the Naval Test Station at China Lake, Calif., about the time you read this. He has been, if I'm not mistaken, the chief scientist there for some years. All this deducing comes from the fact that in his and Jean's Christmas card is an announcement that after February, 1976 they will be living in San Clemente. — **Robert M. Franklin,** Secretary, Satucket Rd. (P.O. Box 1147) Brewster, Mass. 02631; **George G. Bull,** Assistant Secretary, 4961 Allan Rd., Washington, D.C. 20016

35

On the way back from my West Coast trip in November I had hoped to see **Sid Grazi** and **Otto Zwanzig** in Denver, but things didn't work out. However, I just received a letter from Otto at the Matador Motel, Chico, Calif. which I want to share with you. "Surprise? I had your letter acknowledging planned Denver stop-over. In fact it reached me on one of those weekends during which I was in Denver on business, but too late to let you know that I would be in California during your scheduled visit. My presence here developed very suddenly — as a matter of fact within the space of two hours on the Friday before Labor Day. I stopped in on a return from Seattle to see a former teaching colleague at the University of Colorado who is now on the faculty of Chico State University. He introduced me to the Dean of the local business school; in the next breath he asked whether I was available to take on a year's stint as visiting professor here; two hours later I was a member of the faculty. I arrived on campus at 7:00 the morning classes started, and was told then what my first subject would be — class starting at 8:00. With two other previously untaught courses I have had my hands full keeping ahead of the students. Marvelous to be such a versatile Jack-of-all-trades (pardon, eclectic is the word); too bad the tycoons of industry don't recognize these same sterling qualities. If you need any assistance in California, I'll be glad to oblige. Even with four courses, I can find time. It merely means I commute to Denver slightly less often. I'll be back in Denver from about December 21 to January 18."

Bob Forster wrote from Stockholm thanking me for my letter and continued, "Apparently the reunions and golf get better with age. It is good to see favorable, not to say enthusiastic, participation and support. **Nix Dangel** sent us a card from Zurich saying he would arrive at 8:00 p.m. the 15th but we had to leave for Norway on the 11th and got back the 17th, so we missed again. We were in Finland when Nix and Sarah were here in July. One of these days we'll connect. How is Leo? Hope his recovery continued to be favorable. George (their son) is coming over in December."

At the reunion I had a chance to talk with the "baby" of our class. He became 61 on August 12! I am referring to **Vinton K. Ulrich** who, after 15 years with Raytheon's Components Group, became the oldest man ever to be hired by the Prudential Insurance Co. at 56. He is now having a great time selling group insurance. He and his wife Ev live in Waltham. Their son Vinton is a Lt. J. G. at Moffett Field near San Jose. A third grandchild was expected shortly. Daughter Judith is married and has two children, Kristen, 10, and Scott, 4. Her husband is with the Dept. of Public Health.

Another classmate that I saw briefly was **Whit Stueck,** after our '35 crew had its workout. Son W. W. Jr., "Bill", is in his last year at Brown University. Son Arthur is manager of the Utah branch of W. Whitney Stueck, Inc., manufacturers of Connecticut Press Brakes, Band Saws, etc. Whit pilots his own plane, a four-passenger Mooney, to Utah and on his sales trips.

This really is the bottom of the barrel, so now I need help. Don't be surprised if you get a phone call from me some evening — that is if you haven't already written to me. Just had a call from **Ned Collins** — they are still playing golf on these balmy weekends. I think I am pretty clever to have to make sales calls in Los Angeles, San Diego, Atlanta, Miami and Greensboro, N. C., between now and April 19. I will be delighted to hear from you. — **Allan Q. Mowatt,** Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

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By the time you read this you will have received more information about our 40th Reunion. It should be a delightful occasion with a good attendance. Do try to attend. Our reunion gift has been enlarged by contributions from class members and some of them have included news for these notes. **Fred Carten** reports a month of September spent touring Alaska. He says "What a fabulous state!" . . . **John O'Conor,** a graduate member of the class, reports that he has completed 30 years as chairman of the Physics Department at St. Joseph College in Philadelphia. He has now been appointed Director of Cooperative Education at the college.

Your secretary took off in mid-January for six weeks in New Zealand and another four in Australia. **Tony Hittl** has gallantly agreed to substitute as writer of class notes. You have plenty of time to send your news to him before my return in late April. Just write to him (Anton E. Hittl) at 158 Manville Rd., Pleasantville, N.Y. 10570. I can vouch for the fact that he will be happy to hear from any of you. — **Alice H. Kimball,** Secretary, P.O. Box 31, West Hartland, Conn. 06091

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On May 30, 1975 **Ed Corea** retired from his position with the U.S. Navy's contract Settlement Office located at General Dynamics, Quincy, Mass. After an enjoyable summer he accepted a Navy contract for 75 days at

Pomona, California. He expected to complete work in January and return to his well-earned retirement. . . . **Dave Tuttle** confirms that he did spend the first six months of 1975 at Tours, France teaching math at Stanford in France. . . . **Rutherford Harris**' new address is 36 Orchard Ln., Wayland, Mass. 01778. Daughter Sally is married and living in Waltham, grandson John is now 3. Son Ford is married and living in Denver. . . . **James A. Newman** reports he has a family of four daughters and one granddaughter. He is still living at River Rd., Cornwall, Conn. 06796. . . . **Harry B. Goodwin,** 1585 Serenity Ln., Sanibel, Fla. 33957, hopes to make our 40th Reunion. In 1975 he retired after 27 years at the prestigious Battelle Institute, Columbus, Ohio. His final position was Assistant Director of Columbus Laboratories. In 1971 he was on loan to the Congressional Commission on Government Procurement making a study of the Government methods of procuring research and development services. On this assignment he spent time in Europe comparing foreign government operations with ours. In 1973 he was again on loan as Executive Secretary to the Central Ohio Transit Authority in Columbus, Ohio (a public body formed to oversee the privately owned transit operations in Columbus, Ohio and vicinity). His job was to organize the Authority and help the Board recruit permanent management. On July 1, 1975 he retired, sold his home and moved to Florida. He is now renting but has bought land and expects to build in 1976. Two of their four children are married. One lives in Cleveland, Ohio, and the others in or near Columbus, Ohio. They have a grandson almost 2-years-old. — **Robert H. Thorson,** Secretary, 506 Riverside Ave., Medford, Mass. 02155; **Lester M. Klashman,** Assistant Secretary, 198 Maple St., Malden, Mass. 02148

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We're off and running for our 40th Reunion, believe it or not. Prexy **Norm Leventhal** has appointed **Haskell Gordon** as chairman of the 40th Reunion Gift Committee. An initial meeting was held at the M.I.T. Faculty Club, with Haskell presiding. Also present was **Ed Hadley, Bob Johnson,** Norm Leventhal, **Don Severance, Al Wilson** and your secretary. Tentative target is $1 million and a class of '38 scholarship fund. However, the committee will welcome any suggestions you may have. Norm is also interested in any ideas you may have with respect to time and place for the 40th Reunion.

A newspaper clipping informed me that **Jack Bethel** retired as executive vice president of Metcalf and Eddy, Inc., only to form a consulting firm Bethel, Duncan and O'Rourke, Inc. in Boston. . . . **Ascher Shapiro** writes that he was appointed to the rank of Institute Professor at M.I.T. in February, 1975. He was also elected to membership in the National Academy of Engineering in 1974. Ascher resigned headship of the Department of Mechanical Engineering as of July 1, 1974, and very much enjoys being a professor full time again. . . . **Don Weir** has finally come back into our ken after many years. I was sent a magazine article he had written, "Guide to Taking Better Travel Pictures." Don is a photography instructor at the Art Center College of Design in Los Angeles, and owns California Camera in Beverly Hills. — **A. L. Bruneau, Jr.,** Secretary, Hurdman and Cranstoun, 140 Broadway, New York, N.Y. 10005

David S. Saxon, '41, President of the University of California, was jostled and spat upon during an anti-C.I.A. demonstration late last fall at the University's campus in San Diego. (Photo: Wide World)

Supporting the Rights of Free Choice

A return to the era of campus violence of the 1960s?

A brief one, at least, was experienced by David S. Saxon, '41, President of the University of California, during a late-fall visit to that insitutiion's San Diego campus.

Dr. Saxon was appearing at an outdoor rally called by students seeking to end campus recruiting by the Central Intelligence Agency. He said — according to the *Chronicle of Higher Education* — "it was not his role to decide whether it is morally right for the C.I.A. to recruit on campus. The agency is 'a perfectly legal organization,' he said, adding that he would not 'interfere with the rights of citizens to choose for themselves what is proper.' "

The jostling began when President Saxon attempted to leave the meeting, and ten students were expected to be charged with violating the university standard of conduct.

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Arlene and **Ike Weiss** have been transferred by General Motors to England. Their two youngest children will have the added privilege of studying at the American School in London. Meanwhile Ike and Arlene will have to learn to drive on the left side of the street. . . . **MacKenzie Keith** earned a special 25-year award at Penn State University where he is Professor of Geochemistry and Director of Mineral Conservation. Congratulations, Mac. . . . **George Schlaudecker** was elected a Director of Industrial Nucleonics Corp. Our congratulations go also to George whose career includes working for Dupont, founding Maumee Chemical Co., and getting merged a couple of times. . . . **Al Graffeo** announces a new enterprise through which he will offer management consulting based on his successes in military and marine businesses. Welcome to the league of consultants, Al.

We were saddened to learn that **Hendrik Bruynes** died in England. He had conducted the Phyma Laboratories in Rocky Hill, Conn., and had been issued a patent for vortex generators, widely-used aerodynamic devices. — **Hal Seykota,** Secretary, c/o Birchall, 335 Second St., Atlantic Beach, Fla. 32233

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BOTH BARRELS: Two Class of '40 men, and M.I.T. staffers as well, are in the news. **Herb Hollomon,** M.I.T. Professor, has been named the first Japan Steel Industry Professor at M.I.T. The chair is the result of a $1 million gift from Japan Iron and Steel Foundation. . . . Industrial Nucleonics, which manufactures automation and management information systems for industry, has named **Tom Jones,** M.I.T.'s Vice President for Research, to its board of directors. He came to M.I.T. in 1974 from the president's chair at the University of South Carolina.

PRESIDENTIAL MESSAGE: **Jim Rum-**

sey, Class of 1940 president, has sent a message to all of us, urging our contributions to the Alumni Fund. To many of us M.I.T. is a bit remote — over the space of years and a busy life. But M.I.T. is more vital, challenging and attractive than ever. Evidence for this is especially fresh to those of us who serve as counselors assisting the admissions process for undergraduates. Read Jim's letter again and respond if you have not yet done so. The envelope provided for responding has space for your personal notes which will be sent to me for inclusion here. Don't overlook this chance to let all of us know where you are and what you are doing. — **Frank A. Yett,** Secretary, 1405 Ptarmigan Dr., Walnut Creek, Calif. 94595

41

News from the Philippines. **Tirso Gemenez Fajardo** retired as a Brigadier General-Commanding General of the Philippine Army, Manila. General Fajardo lives outside Manila and is now a consulting engineer. Tirso has two sons: one a Technical Sergeant in the U.S. Air Force, the other a Captain in the Green Berets. Mrs. Fajardo — Diane — is a perfume consultant for a French Perfume Company. They have six grandchildren. Thanks for writing and good luck in your retirement.

Bob Wallace Blake writes that he and his wife have just returned from four weeks in Zaire and five weeks in Afghanistan. Bob is concerned with the Technical Assistance Programs for foreign airlines and says that the Afghan Airline is thriving and run almost entirely by Afghans. Bob's wife, Ruth, spent 30 months there ten years ago as head of the Technical Assistance Program.

Our well-known classmate **Howie Samuels** was in the news again with a *New York Times* op-ed article written on the subject of "The Price of New York's Capitulation." . . . A recent *New York Times* article on The Grumman Corp. announced that **Joe Gavin** who was Chairman and Chief Executive Officer of The Grumman Aerospace Corp. would be President and Chief Operating Officer of the parent corporation. Congratulations!

We were informed that **Joseph R. Burns** who received his M.S. degree in E.E. in 1941 died. He worked with G.E. for 35 years at the West Lynn plant. Our condolences to Dorothy and his family.

Don't be bashful. Send in "news." — **Henry Avery,** Secretary, U.S.S. Chemicals, 2863 — 600 Grant St., Pittsburgh, Penn. 15230

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I apologize for having missed the last two issues, but I was moving from Santa Barbara, Calif., to West Hartford. Here I have begun work as special counsel to the Connecticut Public Works Commissioner (Robert A. Weinerman, '48) in preparation of the defense to lawsuits and claims totalling $45 million. Late last August, while still in Santa Barbara, I spent a wonderful evening with Dorothy and **Hans Haac,** who were traveling the West Coast with their four children. They had spent the earlier part of the day with **Larry Stewart** in Pacific Palisades. Hans is a career man at DuPont in Wilmington, Del., where he is a computer systems analyst.

From **Sherm Sackheim** of Clearwater, Fla., comes a long and newsy letter: "We moved here in December, 1973, and the only mistake we made was not moving sooner. No traffic jams here, and we intend to keep it that way. Our taxes are one-quarter of what they were [in New York] and we get more for our dollar. Difficult as things are, only one per cent of the population is on welfare; try that out on our northern friends! Our only real risk is being struck by lightning, this being the lightning capitol of the world.

"Paula is recovering from last year's surgery and is able to enjoy a few more activities now, such as fishing in the Gulf. . . . Son Neil is in his second year at the University of Florida, Gainesville; Andrew is a straight-A high school senior, and Stephanie, 14, is a freshman with a bad case of telephonitis. As you know, I tried to do 'my thing' in advertising in 'Sin City.' Here we do some unusual, thought-provoking advertising, and folks seem to eat it up. It is called 'Respond-A-Page,' something I invented, which has run twelve times in the local paper since February. It is very productive for most advertisers, and now that I have proven it will work in Clearwater, the next step is to introduce it to Sarasota. In my spare time I write ads for many of the Clearwater business firms." Sherm enclosed a full page ad, with thirty spaces for individual advertisers, each offering booklets which are obtained by a corner postcard cutout. Rather ingenious, and we wish Sherm and Paula good luck with these ventures.

Raymond Redheffer, Professor of Mathematics at U.C.L.A., is the recipient of the 1976 Senior U.S. Scientist Award from the Alexander von Humboldt Foundation. . . . **Greg Gagarin** writes, "Early in 1975, Ann, the children, and I returned to our home in Chevy Chase, Md., after a three-year absence. I am now President of Knorr Brake Corp., a subsidiary of Knorr-Bremse, of Munich, Germany. We manufacture all types of brake systems for railways, passenger cars, subways, etc."

Your secretary wishes all a happy 1976, awaits more news and calls, and looks forward to reunions with the northeastern contingent of his colossal class! — **Richard M. Feingold,** Secretary, 115 So. Main St., West Hartford, Conn. 06107

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Bob Jacks, M.S. in Course X, has been elected Director of the American Institute of Chemical Engineers. Bob will begin his three-year term on January 1, 1976. Bob manages expansion administration for the Union Carbide Co. in New York City.

The federal government has awarded $2 million to the Graduate School of Oceanography at the University of Rhode Island. The dean is **John A. Knauss.** This award is for a two-year period and covers a study of the effects of pollutants on marine life.

Everyone should have received **Bob Spoerl**'s letter of November 20, 1975, advising of the 30th Reunion plans. I urge everyone to send their dues of $10.00 and advise as to whether they will attend the reunion. The reunion will be on campus at the newly-renovated Burton Conner House and will run from June 2 to June 6, 1976. Bob Spoerl also advises that a full schedule will be arranged for all children, with supervision provided by the staff of the Athletic Department. — **Russ Dostal,** Secretary, 18837 Palm Cir., Cleveland, Ohio 44126

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I have just returned from a week of golf in Florida to find that these notes are due and a dearth of material.

Fortunately I received a nice letter from **Jim Prigoff** which I feel that you will all find interesting: "I was about to throw the June, 1975, issue away when I decided to take one more glance through and was pleasantly surprised to find myself listed amongst the distinguished alumni. I retired undefeated as national squash tennis champion some seven years ago but still actively play squash racquets. Although I'm getting older and slower, we were ranked third in national veterans doubles this year. Lots of changes for us. Our four children are all long-since married, and our two daughters living in British Columbia, Canada, have produced a total of three grandchildren. Arline is the only grandmother I know who goes visiting and takes along her tent and sleeping bag. They both live in beautiful wilderness country. We sold our home in Scarsdale and moved into New York, and it's been a very interesting year in the city for two people who haven't lived in a major city since college and Boston. We are married 30 years this year and plan to celebrate skin diving in the Caribbean. I've been active in the Explorers' Club and probably since I last wrote Arline and I have camped through East Africa and Hawaii, and more recently this summer we ran the Colorado River through the Grand Canyon with oar-powered pontoon boats. We're also back into skiing which we really both enjoy. Arline is working full time as a social worker, and her evenings seem as busy as her days since she also has been conducting seminars, studying Spanish, running organizations, etc., etc. I recently joined Consolidated Foods as a Group Vice President." I believe that Jim and Arline have made most of the reunions, so hopefully we'll see them in two years.

Why not follow Jim's example and write? — **Dick O'Donnell,** Secretary, 28516 Lincoln, Bay Village, Ohio 44140

48

Willem H. Thorbecke has been appointed President of Dravo International, a newly-created post at Dravo Corp., a diversified engineering, construction, and manufacturing company. It will be located at Dravo's Pittsburgh headquarters and will coordinate all international operations.

For the past 15 years Willem has been active in international business as regional executive, corporate planner, marketing manager, and plant engineer. During this period he has implemented international acquisitions and has managed sales and manufacturing operations in Europe, Brazil, East Asia, and Australia.

In October I visited **Bill Katz** at his office in Watertown. Bill is a vice president at Ionics, Inc., manufacturers of equipment to demineralize water. Ionics equipment is sold internationally. The recent economic growth in the Middle East has allowed those

Willem H. Thorbecke, '48

countries to increase their puchase of equipment for demineralization of their water supplies.

Rose and **Leon LaFreniere** celebrated their 25th wedding anniversary with a ten-day trip to Hawaii. They spent six days at Waikiki beach and four days on the island of Kauai. Leon was impressed by the volcanoes. He was hoping the United airline strike would strand Rose and him in Hawaii.

Leon was presented the District Award of Merit from the Boy Scout district where he has been active for many years. His son, Leon, Jr. is 21 and active in the troop as assistant scoutmaster. Paul is 17 and is president of an Explorer Post that specializes in the study of Indian lore. — **S. Martin Billett,** Secretary, 16 Greenwood Ave., Barrington, R.I. 02806

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A news release has come from Soil Testing Services, Inc., announcing the appointment of **Clyde N. Baker, Jr.** as Executive Vice President. Mr. Baker has been with Soil Testing Services since 1954, serving as Project Engineer, Chief Engineer, and Vice President. He has had broad experience with all aspects of the firm's geotechnical engineering business and will continue to serve as a principal engineer of the firm, responsible for coordination with their 21 affiliated offices. . . . **James Margolis** of Margolis Industrial Services, Mamaroneck, N. Y., is the 1975 recipient of the 4th Golden Interpetrol Award for his studies on new energy resources. . . . **Douglas F. G. Haven** has been admitted to membership in the firm of V. J. Shah & Co., Inc., a member of the Boston Stock Exchange.

U.A.L., Inc., the parent company of United Airlines, has announced the election of **Fujio Matsuda** of Honolulu, Hawaii, to the boards of directors of both U.A.L., Inc., and United Airlines. Dr. Matsuda, an authority on civil engineering and formerly a transportation administrator, was elected President of the University of Hawaii in 1974. . . . **Ralph R. Ragan,** head of the Planning Staff of the Charles Stark Draper Laboratory, has been elected to the position of Vice President of Publications for the American Institute of Aeronautics and Astronautics as of last January 26. Ralph served as Associate Editor for the A.I.A.A. *Journal of Spacecraft and Rockets* from 1963 through 1966 and Editor-in-Chief from 1970 through 1974. Ralph's responsibilities will include the direction of the *A.I.A.A. Journal, Journal of Spacecraft and Rockets, Journal of Hydronautics, Astronautics and Aeronautics,* and the *Progress in Astronautics and Aeronautics Series.*

Kenneth N. Stevens, Professor of Electrical and Bioengineering in the Dept. of Electrical Engineering and Computer Science, and Head of the Speech Communications Group in the M.I.T. Research Laboratory of Electronics, was elected President-elect of the Acoustical Society of America at the Society's recent annual meeting in Austin, Tex. . . . **Ricardo Haegler** writes that he has just returned from Boston where he attended the Advanced Management Program at the Harvard Business School, together with **Chuck Ehlers.** . . . **Raymond E. Beale, Jr.** is Chief Civil Structural Engineer with the consulting architectural engineering firm Max O. Urbahn Assoc., Inc. Ray does consulting work for the U.S. Postal Service in the New England and Eastern New York areas.

G. Robert Roy, a civil engineering graduate, died May 30, 1975. He had retired as an engineering executive of the Port Authority of New York and New Jersey and was 52 years old. Mr. Roy had been with the bistate agency for 22 years at his retirement last November. He joined the Port Planning and Development Dept., became a licensed professional engineer, and in 1964 became Special Assistant to the Director of the Marine Terminals Dept. He was also a graduate of St. Lawrence University, and had served in the Navy in World War II as a patrol bomber command pilot. He leaves his wife, the former Margaret Snow; two sons, Christopher and Matthew, and a daughter, Robin, residents of Katonah, N.Y. — **Arthur S. Turner,** Secretary, 175 Lowell St., Carlisle, Mass.; **Richard F. Lacey,** Assistant Secretary, 2340 Cowper St., Palo Alto, Calif.

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Bob Avakian has joined Sylvania (Needham, Mass.) in new product development. . . . **George Sebestyen** has been named Vice President and General Manager of the Research and Engineering Division of Boeing Aerospace Co., Seattle. . . . Colonel **John D. Griffiths** is now Chief of the Advanced Technology Division of the Air Force Technical Applications Center, Patrick A.F.B., Fla.

The **Ari Miliotes,** besides being new owners of a gourmet shop in Clearwater, Fla., are the proud parents of a year-old boy. (That's for all of us whose children are in college!)

Sanford Rock was appointed Vice President of Marketing for Allied Chemical Corporation's Nuclear Products. Sandy joined Allied Chemical right after graduation and has served in sales and marketing for the company's Industrial and Special Chemicals divisions. He has been Director of Marketing for nuclear fuels since 1971. — **Dave Howes,** Secretary, Box 66, Carlisle, Mass. 01741; **Chuck Masison,** 76 Spellman Rd., Westwood, Mass. 02090; **Lou Mahoney,** 14 Danby Rd., Stoneham, Mass.

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Having exhausted the results of the Class questionnaire, we have come upon the winter freeze and, accordingly, do not have too much news to report. Like any other gregarious soul, however, we crave attention so please send us some news.

Roy Salzman served as project director of the recently issued report by the National Bureau of Standards on Effective Use of Computing Technology in Vote-Tallying, done at the request of the Federal Elections Commission. . . . **Denny Shapiro** has moved and is now "on top of . . . [the] hill," where he has plenty of room for gardening and touch football. He is only about ten minutes from his office, and Sue can walk to the M.B.T.A. to get to her law office, and their children (who are 9, 7, and 5 at this writing) can walk to school. He was recently in Brazil and Venezuela, and is planning a family skiing expedition in Alta this month. For those who are interested in a game of touch football, Denny's new address is 24 Essex Rd., Chestnut Hill, Mass. 02167.

John R. McMaster passed away on September 23, 1975 of cancer, and is survived by his wife Nina; three daughters Nikki, Sue, and Diane; and his mother, Mrs. Ann McMaster. "Bert" McMaster joined the Lockheed-California Co. in July of 1955, immediately following graduation with a B.S. in aeronautical engineering. In 1967, Bert was appointed head of aerodynamics in Advanced Development Projects (A.D.P.) and, in 1969 he was promoted to project manager in A.D.P., responsible for all aerodynamic, propulsion and thermodynamic engineering analyses on the SR-71 and its YF-12 version, the U-2 and various more advanced aircraft designs.

Bert was an Associate Fellow of the American Institute of Aeronautics and Astronautics (A.I.A.A.), a professional aeronautical engineering society, and for the past few years served on the A.I.A.A.'s Aircraft Design Technical Committee. — Your co-secretaries: **Marc S. Gross,** 3 Franklin Ct., Ardsley, N.Y. 10502; **Allan C. Schell,** 19 Wedgemere Ave., Winchester, Mass. 01890

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Save June 4, 5 and 6 for the 20th reunion at the Institute. Details were in the first mailing sent to all class members in early February. Please remit your class dues and return the reply forms to continue to receive reunion information. For classmates unable to attend, a copy of the class questionnaire will be mailed to all who send dues. If you would like to be included in the reunion committee, write or call Chairman **Mickey Reiss,** c/o Gamewell/Alarmtronics, 91 Bartlett Street, Marlboro, Mass. 01752, or telephone (617) 481-6800. You may also contact Vice Chairman **Bill Dickson,** Director of Physical Plant, M.I.T. Some of those helping on the committee are: **Lloyd Beckett, Warren Briggs, Walt Frey, Margie Gilson, Bill Grinker, Ted Korelitz, Bob Malster, Ron Massa, Ray Mennell, Bill Northfield, Bob Pollard, Arnie Schindler, Dave Shefrin** and **Guy Spencer.** Another list in the next issue will include additional names and area chairmen. Add your name to the list. Come to the reunion and see your friends.

We have received notice of the death of **John O'Dowd** in Hot Springs Village, Ariz., in September, 1975. More information would be appreciated.

Dave McBride has been named Director of Production Planning of Youngstown Sheet and Tube. Dave has been in numerous positions since joining Youngstown in 1962, and moved to corporate headquarters in 1973. The McBrides have two sons and a daughter. . . . **Paul Polishuk** is now Deputy Director, Office of Telecommunications, U.S. Dept. of Commerce, Washington, D.C. . . . **John Seeger** writes that he is still working on his thesis at the Harvard Business

School. . . . **John Sirmalis** recently received his Ph.D. in Mechanical Engineering at the University of Rhode Island. John completed the academic work while at the Underwater Systems Center in Newport, where he has recently been manager of work on the advanced lightweight torpedo program. John and Elaine have four children. . . . **Ben Tenzer** is working on power plant design and construction for Ebasco Services, Inc., in New York. . . . The New York area alumni have revived periodic class luncheons. The first was last November. Please contact **Ed Baker** at Gordon, Hurwitz, Butowsky, Baker, Weitzen and Shalov, 299 Park Ave., telephone 486-1550. — Cosecretaries: **Bruce B. Bredehoft,** Box 181, Dover, Mass.; **Mrs. Lloyd Gilson,** 35 Partridge Rd., Lexington, Mass.

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I pass on a short set of notes from a recent class telethon in Cambridge, where Class Agent **Ed Safran** had gathered **Chuck Staples, Dick Sampson, Bob McAuliffe, Ron Stone,** and me to contact over 50 classmates for gifts to the Alumni Fund.

Among those we spoke to were **Edward Getchell,** who left engineering, returned for graduate work to the Sloan School, and is now with the Institute for New Enterprise Development in the Boston area. . . . **Don Tyra** is busy with his new company in Orlando, Information Processing, Inc., with the bulk of his time spent on the development of a new COBOL compiler rather than enjoying the sun with his wife, Joyce, and their two children in nearby Winterpark. . . . **Ivan Schmidt** is a metallurgist with an investment casting firm in Connecticut while fellow Course IIIer **Wayne Worrell** is on sabbatical from Penn State and spending the academic year at Berkeley.

Only one item in the mailbag, from **Terry Gildea,** who has moved with Marilyn and their five children from Colorado to California with Hewlett-Packard, for whom he travels extensively as calculator sales manager for Latin America and Africa.

'Hope that 1976 is getting off to a good start for all! It only takes a few minutes to drop a note to **Phil Richardson,** 180 Riverside Dr., New York, N.Y. 10024; **John Amrein,** 770 Greenwood Ave., Glencoe, Ill. 60022; **Adul Pinsuvana,** 49 Seri Road, Seri Village, Hua Mark, Bangkok, Thailand; **Bob Muh,** 907 Chantilly Road, Los Angeles, Calif.; and myself, **Allan Bufferd,** Secretary, 8 Whitney Rd., Newtonville, Mass.

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In a recent Alumni Fund mailing, class president **Ray Harlan** said that you will be seeing "plenty of class notes from a new, eager secretary." Let's keep this new secretary eager by sending him something to write about you. The Harlans are Wayland residents, and our local paper reports that Ray's wife, Pat, who has a degree in biology, was appointed a member of the Wayland Board of Health.

Lawrence Kravitz and his wife, Yvette, have announced the birth of their second daughter, Jennifer Carol, in May. . . . **George Meyers** is a major in the Air Force serving as Chief of the Engineering Liaison Office for Expansion of the National Military Command Center at the Pentagon. George keeps trim with a 15-mile bicycle ride to work every day, thus earning our derailleur-of-the-month award.

Turning to earlier notes (c. 1974), **David Camenga,** M.D., was a collaborative investigator at Emory University's center for studies of multiple sclerosis. . . . **Sanford Miller** was associate professor of mathematics at the State University of New York, Brockport, while his wife, Jill, was teaching at the Rochester Institute of Technology. They and their daughters, Heather and Heidi, spent a year in Romania, Poland, and Israel on several exchange grants. . . . **Thomas Cover** was made a fellow of the I.E.E.E., in recognition of contributions to learning and information theory. . . . **Alan Bardwick** was manufacturing manager for M.S.I. Industries, whose products include ore processing equipment and kilns. . . . **Charles McCallum** was practicing securities and general corporate law and held posts as first vice president of the Greater Grand Rapids Chamber of Commerce, secretary of the Grand Rapids Transit Authority, member of the Governing Council of the National Municipal League, and a member of the Representative Assembly of the State Board of Michigan.

Food for thought: when Mozart was our age, he had been dead for two years. Quick . . . whistle a few notes for publication in *Technology Review*. — **Robert F. Stengel,** Secretary, 152 Oxbow Rd., Wayland, Mass. 01778

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Xavier L. Simon is General Production Manager for the Consumer Products Division of Anderson, Clayton and Co., S.A., Mexico's largest food manufacturer. . . . **Tom Sheahen** has joined the Office of Energy Conservation at the National Bureau of Standards. His industry program is aimed at helping industry conserve what energy they have. . . . **David R. Spencer** was promoted to Vice President of Engineering for Datalog Division of Litton in November of 1974. He and his wife, Pam, bought a home in Melville, L.I., N.Y., last September. He has two sons, Marc, 5, and Scott, 1½. . . . **Donald A. Martin** has been appointed Professor at The Rockefeller University. Professor Martin has been a member of the University's faculty since 1967. He did graduate work at the University of Chicago, where he held a National Science Foundation Fellowship, and as a junior fellow at Harvard University. He has been a member of the Executive Committee of the Association for Symbolic Logic since 1974 and is an Association delegate to the International Union for the History and Philosophy of Science. He makes his home in Brooklyn, N.Y. — **Gerald L. Katell,** Secretary, Parking Structures International, 250 E. First St., Los Angeles, Calif. 90012

63

December. Very depressing — class notes time again and no news from the class of '63. This month I am forced to scrounge up my own news.

I traveled to Tokyo again this month, where my company has a joint development project with Bridgestone Tire Co. We are automating a tire tread production line, the first time anyone is attempting this. While in Tokyo I spoke with **Harold Solomon,** a visiting scientist at the Geophysical Institute of the University of Tokyo. Getting in touch with Harold was no mean feat. The telephone number I had was obsolete (I later found out) and Harold's ex-landlady spoke no English. I know enough Japanese to make myself understood, but I can't understand what people say to me in response. The landlady knew I wanted to speak to Solomon-san, and if he wasn't there to have him call me at my hotel. It must have been very frustrating for her not to be able to tell me that he had moved several months ago.

I finally reached Harold two days later at the University and he related his past M.I.T. history to me. He has visited or lived in Japan, Australia, and Israel, among others, and cruised the waters of numerous oceans on research ships (the Atlantic, Pacific, Arctic and Antarctic). After graduation Harold remained at M.I.T., getting his Ph.D. in meteorology (fluid dynamics option) in 1969. Since 1972 most of his time has been spent in Japan studying ocean currents in that area. Currently he has a grant from the N.S.F. to support his work. His spare time is spent skiing and climbing in the mountains of Japan.

My other piece of news may not be news to many of you. A recent mailing informed me that **Woody Bowman** was running for office again — not class office, but for a seat in the Illinois House of Representatives. Among the issues in the campaign — school financing, passage of the equal rights amendment, banning of handguns, extending collective bargaining rights to public employees, the passage of "no-fault" insurance laws, and corruption in Chicago's machine politics. The mailing was under the letterhead of M.I.T. Alumni for Woody Bowman, and included on the committee were **Jim Champy, Marty Schrage,** and **Pete Van Aken.** A cocktail party in Woody's honor was sponsored by the committee December 14 in Boston.

End of news, end of column. More next month — if I get some news from some of you. — **Mike Bertin,** Secretary, 18022 Gillman St., Irvine, Calif. 92715

64

Well, classmates, the news this month is very scant. Please write so we can write.

Allan N. Press is now an Associate Professor in the school of Social Welfare at the University of Kansas at Lawrence. . . . Another classmate in academia is **Ronald Francis.** He is now chairman and Professor of Photographic Science and Instrumentation Division of the Rochester (New York) Institute of Technology. . . . **Al Russell** is trying to turn himself into an exploration geophysicist in the employ of Texaco Exploration Canada in Calgary, Alberta. His recreational activities include hiking and climbing in Banff National Park and skiing. . . . **David J. Dunford** is still with the Department of State. He has just finished an exciting assignment as Acting Chief of the General Commercial Policy Division. It is one of the three divisions in the Office of International Trade which deals with trade policy toward the Third World. David is now at the Economics Department at Stanford University for this academic year.

We actually had one class hero this month — **Clarence Malick.** "Buck" is experiencing several changes in his life. After 2½ years with General Finance, he is now assistant General Counsel for I.T.T. Thorp Corp. He and his wife have divorced after ten years and one child. By the time you read this he will have purchased a house on Lake Wissota (Rt. 5 Box 311), Wisc. He says all are welcome when in the area near Eau Claire for fishing, swimming, water skiing or just plain drinking.

We are headed for Massachusetts in a few days. Having finally sold our home in Peabody, we are gleefully anticipating that ceremony known as "passing of papers" which is scheduled for December 29. Once that's over, we can seriously begin the local househunt. As one might expect — appreciating Murphy's law and the like — the Washington, D.C., area is the most expensive housing market in the U.S. today, particularly Montgomery County, Maryland, the community in which we're now renting and would like to settle.

I "bump" into **Mike Monsler** from time to time in his new location at S.A.I., Crystal City, Virginia. He's fine and enjoying his new position. He and Barb are awaiting that magic customer who wants to buy their home in Reading so they can complete relocation to these parts. Let's all hope it happens soon — like long before all of you see this in print.

Remember when you get to Washington — get in touch (301-340-7373). Also, remember M.I.T. in your hearts and with your checkbooks. Write. Ciao. — **Steve Schlosser,** Secretary, 12401 Bobbink Ct., Potomac, Md. 20854

65

A few heroes sent information on the back of their Alumni Fund envelopes, and a few press clippings have arrived, but the mail bag is still mightly light.

Robert B. Roper made the *Wall Street Journal* in an article on computerized commodities trading. He is co-founder and Vice President of Thomte-Roper, Inc. . . . **Ron Wilensky** is a project manager at T.C.I., a communications electronics firm in Mountain View, Calif.; Melanie and Ron are the proud parents of Elena Michelle, their first child, born August 18, 1975. . . . **Doug Patz** received his Ph.D. in physics from the University of Arizona last May. . . . **Edwin Kampmann** was awarded a Ph.D. in City Planning from Berkeley, and is teaching in the Department of Public Administration at California State College, Dominguez Hills; his dissertation was on solid waste management. Ed lives near the Pacific and uses his spare time for back-country outings, photography, reading, and aerobics.

Bruce Zotter received his law degree from George Washington last May, and has joined the Washington, D.C., law firm of Finnegan, Henderson, Farabow and Garrett, specializing in patent law.

Bruce Golden, after receiving his masters in electrical engineering in 1966, went "up the river" to Harvard Law, receiving his J.D. in 1969. He has recently become a partner in the Chicago law firm of McDermott, Will and Emery, specializing in corporate and S.E.C. law. He plays trumpet with Bobby Christian's Big Band every Wednesday at Orphan's in Chicago's new town area; now any '65er who is in Chicago on a Wednesday night knows where to go!

Bruno, the Class of '65 honorary St. Bernard, is now over 8-years-old, well into late middle age, but shows no signs of maturing. This past summer he was sniffing casually down the middle of Route 16 near our home when he was hit by a Volkswagen. Neither Bruno nor the V.W. was seriously injured, but Bruno now shies from cars. I have not heard how the V.W.'s behavior has changed. — **Edward P. Hoffer,** M.D., Secretary, 12 Upland Rd., Wellesley, Mass. 02181

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The length of this month's column should be a good hint to those who have not written to me recently. For the past two years, Eph McLean, '70, has been the Director of the Center for Information Studies at the U.C.L.A. Graduate School of Management. Eph, who recently became a tenured associate professor at U.C.L.A., is taking a sabbatical leave to finish writing a book. . . . **Mark Fineman** has left Syracuse University and joined Digital Equipment Corp. in Maynard, Mass. . . . Kiki and Mike Rosenblum, '68, are enjoying their jobs in New York's garment center. What is an M.I.T. graduate doing in a place like that? . . . Mike reports that **Larry Gottlieb** is a member of a band called "Liberty" that has cut an album and appeared with John Denver during a recent concert tour.

Naigzy Gebremedhin '68, is the general manager and chief planner of a Pan-African housing group in Addis Ababa. He keeps busy by planning children's villages in Ethiopia. The recent prolonged drought left many children destitute, but Naigzy has been encouraged by the assistance from many countries. . . . Last fall **George Starkschall** was musical director of "Fiddler on the Roof" with the Hyde Park Jewish Community Center in Chicago, and he presently is musical director of a production of "Man of La Mancha". George is both Chief Physicist at St. Francis Hospital in Evanston, Ill., and Assistant Chief Physicist in the Radiation Physics Dept. of a V.A. hospital. — **Jim Swanson,** Secretary, 669 Glen Rd., Danville, Calif. 94526

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Winter has descended on your nation's capital, but we were lucky enough to both have a trip to California recently to warm up and see the sights. In Los Angeles we found **Dick Turner,** who is finishing up a tour in the Air Force, where he has been since graduation, and by the time you read this he should be a civilian. Still a bachelor, he enjoys social life in Los Angeles a lot more than where he was previously assigned — Omaha. Down in San Diego we spent an afternoon with Robert (Ph.D. 1969) and **Margaret (Eikrem) Keller.** Margie has finished her residency in pediatrics and is doing research in infectious diseases. Rob is applying his physics background to radiology research, and was recently on the receiving end of an x-ray machine as a result of a skate board accident which has him hopping around. They both enjoy the southern California life style.

Moving up to colder climes, a note from **Charlotte Babicki** reports all is well in Yellowknife, North West Territories (62°N, 114°W). She has finally met another M.I.T. grad in town and was wondering whether they should organize an alumni club. M.I.T. seems to have an image problem in town — nobody ever heard of it; and the Canadian usage of the term "institute of technology" implies a sort of junior college. Her brass rat is admired as "just a cute Canadian beaver." I think this shows a clear need for a club, and I hope that the Institute sends some speakers up there to improve its image. . . . Also in the exotic, far-off vein is a note from **Mike Rabinowitz** that he and Diane are outfitting a sailboat named *Stuff* for a circumnavigation.

Our final item is more down to earth. **Dave Jansson** has been appointed Assistant Professor in the Department of Aeronautics and Astronautics at M.I.T. . . . That's all for this month; hope we'll be hearing from you soon. — **Gail** and **Mike Marcus,** 2207 Reddfield Dr., Falls Church, Va. 22043

69

Here's the latest – is it ever late. The most recent information available is from Oct. 21, 1975. Given delivery times I would hazard a guess that this report is right up-to-the-year.

Irene Greif writes that she has been an Assistant Professor of Computer Science at the University of Washington in Seattle since September, 1975. . . . At the end of June this year, **Joseph Horton** plans to complete his residency in radiology and move to a one- or two-year fellowship in neuroradiology at Presbyterian Hospital, Pittsburgh.

Bringing us up to date almost from graduation is **Richard Kremsdorf.** Richard married the former Debby Lipton (Simmons '69) in 1970. He received his M.D. at the Albert Einstein College of Medicine (Bronx, N.Y.) in 1973 and is currently finishing internal medicine training at the State University of New York at Buffalo. Richard's fellowship in pulmonary diseases will commence in July at the University of California (San Diego).

Carolyn Scott has escaped the "smog and noise of L.A." and moved to Reno, Nevada, where her husband Larry is on the faculty of the chemistry department at the University of Nevada. Their children, Jenny (8) and Nancy (5), and they are enjoying the country life on two and a half acres of pastureland. I hope there is a home somewhere on or about the pastureland; Carolyn's letter was silent on that point.

That's the way it was in late December, 1975. — **Peter Peckarsky,** 950 25th St., N.W., Washington, D.C. 20037

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Remember our class reunion!! The Alumni Association needs your help to make it a success so volunteer if you live in the Boston Area.

William F. Hederman, Jr. writes: "I am leaving the Rand Corp. to join the staff of the Congressional Budget Office. At Rand, I have been doing research on the role of federally funded demonstrations in the stimulation of technological innovations. This research is funded by the experimental technology incentives program of N.B.S." . . . Lucy and I had dinner with **Chris Brew-**

Innovation Center's Television Tennis

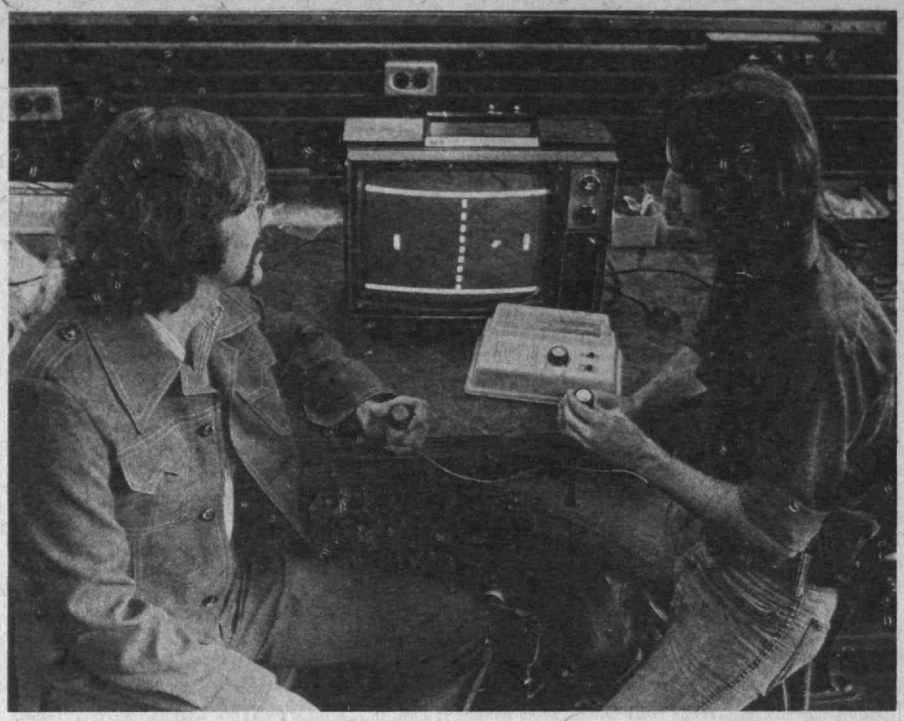
"All the scientific know-how in the world accomplishes very little unless an engineer understands that the process of inventing also embodies marketing, entrepreneurship, and production."

That sounds like a quotation from the textbook of Professor Yao T. Li, Director of the M.I.T. Innovation Center. But it's a lesson come home to his student, Glen Dash, '75, who is the inventor — and now the promoter, too — of the lowest-priced electronic tennis game ever to hit the consumer toy market.

Television Tennis was conceived, researched, and developed by five students in the Innovation Center during 1974-75. Now it's being offered to retail stores with a suggested price of about $65, putting it several notches in cost below competing games; it's billed as the simplest and most compact television tennis game on the market, and it has such advanced features as an automatic paddle and practice wall for viewers who want to play alone.

Mr. Dash took the idea for a television tennis game from the M.I.T. Innovation Center to Peter Stepanek, President of Executive Games, Inc., Boston, last summer. Mr. Stepanek was impressed: he liked the game, and he liked the idea of the Innovation Center, emphasizing the creative process and the importance of entrepreneurship. Now Mr. Dash is working as Chief Engineer of Executive Games, and 250,000 units are scheduled to be on sale by spring.

"At times it's been only 5 per cent invention and 95 per cent perspiration," says Mr. Dash. "But after seven design phases and a concentrated 'course' in sales, we've been told by retailers like Sears and Gimbels that we have a real winner on our hands."



A master panel, two hand-operated controls, and a small switching box plugged into Channel 3 of any black-and-white or color television and you're ready to play Television Tennis. It's a product of Glen Dash, '75, and four other students working in the M.I.T. Innovation Center, and Mr. Dash is now promoting it as Chief Engineer of Executive Games, Inc. Students who worked with Mr. Dash — all members of the Class of 1976 in electrical engineering — are David Agans (right, above), Joseph Corkery, Michael Shields, and Gabor Szakacs.

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ster last night in Dallas. He seems to be enjoying his job with GeoSources in Houston and is doing some interesting traveling. . . . The only other news I have concerns me. I have decided to join the law firm of Moorman and Tate in Brenham, Tex. (my father's firm). Brenham is a town of 10,000 people located between Houston and Austin. It is blessed with a landscape somewhat like New England's. Lucy and I hope to find a place to live in the country there after I take the bar exam. — Please continue to write and advise me of your activities. — **Hal Moorman,** 3461 McFarlin, Dallas, Tex.

74

This month's column is rather small, but it is printed here, on schedule.

Mark C. Oakes writes: "All is well in Newport News, Va., the shipbuilding capital of the world. All Sigma Tau Dekes are asked to stop in when in the area and talk over old times over a case or two."

Maureen Alexander is a second-year medical student at Southwestern Medical School in Dallas, Tex.

And that's it! — **Dennis Dickstein,** Secretary-Treasurer, 16A Forest St., Cambridge, Mass. 02140

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David Katz was married to Karen Kutscher on August 23, 1975 in Baltimore. They took a trip through Canada to Seattle, where he attends the University of Washington. He's in the atmospheric science department, working on a project to create a computer model of the air-ice-water system. Karen works for S.E.R./Jobs for Progress, helping under-employed professionals find jobs in their fields. (Sounds like a good service to know about these days.)

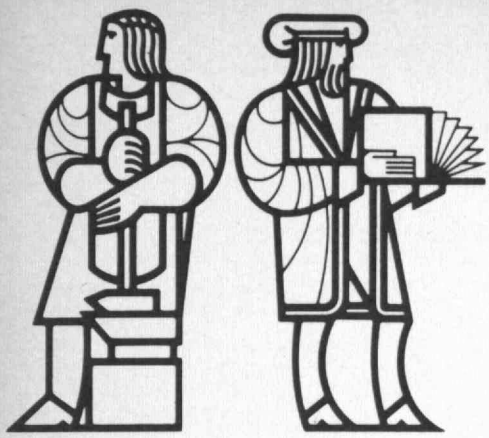
Second Lieutenant **Paula A. Lieberman** graduated from the U.S. Air Force space systems analyst course at Keesler A.F.B., Miss. She studied the principles and laws of ballistic and orbital motion and characteristics of space sensors. Paula has been assigned to Peterson Field, Colo., where she will serve with a unit of the Aerospace Defense Command.

Susan Costa gave a talk entitled "Issues of Contemporary Religious Life from a Woman's Perspective" in October at St. John the Baptist Church, New Bedford, Mass. Susan is attending a three-year master of divinity program at the Boston Theological Institute at Weston School of Theology, Harvard Divinity School and the Episcopal Divinity School. Her field is education in campus ministry.

Ilene Gordon heard from two classmates: **Jeff Schweiger** is in Pensacola, Fla., at the U.S. Naval Air Station. After a summer of "Aviation Indoctrination," he is stationed with Training Squadron Ten, attending Basic Naval Flight Officer School. He should be flying by the time this article goes to print. . . . **Roy Greenwald,** who spent several months in Hawaii after graduation, is now in Berkeley, Calif., working for Bechtel. He's using mechanical and chemical engineering, as his job involves the handling of questions and specification changes arising from the construction of a waste water treatment plant. He has applied to masters programs at Berkeley and Stanford for next year and after that will probably come back to M.I.T. for a Ph.D. Or he may just work for two years before returning to Cambridge.

Wayne Christian has recently returned from a trip to the West Coast, where he visited Jeff Rosner, '74. No settling down for Wayne yet. He plans to travel until his money runs out.

As always, I look forward to hearing from you all. — **Jennifer Gordon,** Secretary-Treasurer, 5 Centre St., #32, Cambridge, Mass. 02139



The MIT/Marine Industry Collegium

A partnership for the development of business opportunities in ocean-related products and services

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What is the Collegium?

The MIT/Marine Industry Collegium was formed in 1975 as a working partnership between MIT Sea Grant and U.S. industry. Its purpose is twofold: to identify specific marine business opportunities, and to help companies translate these opportunities into profitable business ventures.

Seventy-six companies, many world leaders in their fields, have joined the Collegium during its first year. Through Opportunity Briefs and meetings, the Collegium keeps member companies informed on selected economically significant business opportunities that arise from research in progress, and on ideas that can be put to work in the development of profitable new enterprises. Members' research needs and business interests, in turn, give additional, industry-oriented direction and relevance to M.I.T. Sea Grant's research, education, and advisory services.

In accordance with the National Sea Grant Act, the Collegium is supported on a matching funds basis. Participating companies, MIT, and the Federal government, as partners, share the Collegium's operating costs.

How Can Your Company Benefit from Collegium Membership?

Collegium members receive five Opportunity Briefs a year. Each Brief presents a specific marine business opportunity, outlining market characteristics, technical requirements, environmental and regulatory considerations, and market potential. To assist companies in further investigations of each opportunity, an extensive bibliography and references to related research are included.

The first year's topics for Opportunity Briefs are "Chitin and Chitin Derivatives" (September 1975), "Offshore Mining of Sand and Gravel" (November 1975), "Mechanical Systems for Underwater Tasks" (January 1976), "Underwater Welding" (March 1976), and "Computer-Controlled Submersible Instrumentation and Survey Systems" (May 1976). To provide closer links between Collegium members and M.I.T. faculty, regional meetings are held with member companies to discuss and review the Briefs with subject experts, and to discuss topics for future Opportunity Briefs and Sea Grant research projects.

Member companies also receive abstracts of all M.I.T. Sea Grant reports, copies of these reports upon request, and information on all major Sea Grant activities and marine-related events at M.I.T.

We Invite Your Company to Join the MIT/Marine Industry Collegium for the Year 1976-1977

We are now working with present and prospective Collegium members in selecting topics for next year's Opportunity Briefs, and in designing additional new programs for Collegium members. For additional information, please call or write: Norman Doelling, M.I.T. Sea Grant Program, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, Telephone (617) 253-4434.

A Special Issue on Offshore Oil:
Kenneth O. Emery on Why Offshore Oil?
John W. Devanney III on Managing the Bonanza
Robert J. Stewart on Offshore Oil Spills
Stephen F. Moore on Environmental Impacts of Spills